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A NEW PLANETARIUM.

The old fashioned orreries, which were constructed to show the arrangement of the solar system and the motions of the planets around the sun, were somewhat rude in their mechanism, and were apt to mislead from the conspicuousness of the rods and wires by which the astronomical movements were imitated.

Signor N. Perini, an Italian long domiciled in London, and whose name is well known as a successful teacher for the civil service and the army, has invented a new planetarium which is free from most of the defects of its predecessors.

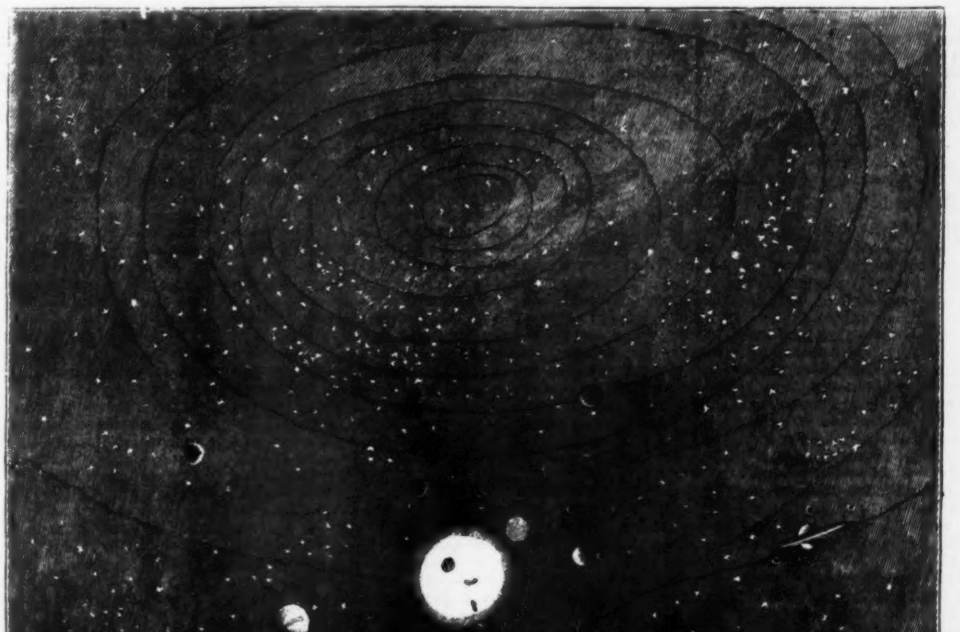
A high circular chamber or box, standing on twelve wooden pillars, is erected in the midst of an ordinary-sized room, with a ceiling higher than usual. On entering underneath this chamber, and looking up, a dome is seen, deep blue, and sprinkled with stars. The chief northern constellations are in their proper places, and round the base of the dome are the names of the signs of the zodiac.

Suspended from the top of the dome by a narrow tube is an opal globe, lit inside with gas, and representing the sun. From wires almost invisible the planets are suspended around the sun, of sizes and at distances approximately proportionate to the real sizes and distances, and each having the proper inclination to the plane of its orbit. The various moons are in their places, and Saturn has his rings.

Thus far, however, all these miniature celestial bodies have been in a state of quiescence. Presently Signor Perini, by simply turning a key, sets the solar system in motion, slowly or swiftly, as he pleases. The sun turns on his axis, and the planets revolve around the sun in proper elliptical orbits, which are traced around the inside of the dome, which is 14 feet in diameter at its base and 14 feet high. By an ingenious watchwork arrangement inside the earth, which is the size of a walnut, our world is made to revolve on its axis, which latter always points to the same quarter of the heavens. In like manner the moon goes round the earth.

The machinery is arranged in the chamber above the dome, clock-work being the motive power, the originality in the arrangement being the method by which the inventor effects the elliptical motion of the planets. Not a sound is heard, the machinery works, like its great prototype, in solemn silence.

Signor Perini, who has been prompted to this work solely from the enthusiasm of a mechanician, has devoted his nights and mornings to this structure for seven years, and has spent on it about £700. The earth alone cost £40. The planetarium can be made of any size, from the dome of St. Paul's to a little thing that might be used for school instruction. It is now standing at 77 Newman Street, Oxford Street.—*London Graphic.*



A NEW PLANETARIUM.

MOLECULAR CHANGE IN WIRES.

In his recent interesting researches upon electricity, M. Gaston Planté observed that powerful electric currents when passed through fine metal wires had the property of rendering them very brittle. The currents employed by M. Planté were the discharges from his great rheostatic machine of eighty condensers (described in the *Comptes Rendus* for Oct., 1877, and *Recherches sur l'Electricité*) which gives a spark of 0·13 meter in length. Lightning rods, according to M. Planté, are also found to become brittle in course of time, by the passage through them of lightning discharges, and their failure is sometimes traceable to a break in their continuity which has resulted from this form of weakness. Again, it has been observed by electricians that the platinum wires of the lightning arresters inserted between the ends of submarine cables and the shore land lines in order to guard them from the strong and damaging atmospheric and earth currents, which frequently circulate in the latter, are apt to become less elastic and more easily broken by use, doubtless owing to the passage of these currents through them. The nature of the molecular change produced in the wires by the rush of current through them is as yet a mystery, but the fact that it does take place is beyond question.

Aware of this observation of M. Planté's, it occurred to Mr. W. H. Preece, President of the Society of Telegraph Engineers, to test whether a similar effect would be noticeable in ordinary iron telegraph wires. These wires are, it is true, subject to very feeble currents in general, for the battery currents used in telegraphing are not to be compared in strength with those employed by M. Planté, and moreover the diameter of the No. 8 telegraph wire is many times that of the capillary wires of the French investigator. But, on the other hand, the long-continued action of the telegraphic currents might, Mr. Preece thought, have some influence in making the wires brittle. Further, though Mr. Preece did not, we believe, specify this agency in his paper on the subject read before the Society of Telegraph Engineers on Wednesday, February 11, the circulation of earth currents in the wires might have assisted in the structural deterioration we are now considering. The wire chosen for the test was cut from a telegraph line erected 36 years ago between Bishopstoke and Botley, in Hampshire. It was of No. 8 B. W. G., but since exact measurements of the diameter and mechanical strains of telegraph wires were not made in those days, it was impossible to arrive at a correct value for the original dimensions and strength of the wire. The wire is now coated with rust, but is otherwise in fair condition. There are 69·33 yards of it, having a diameter of, say, 175 milles (0·175 inch), and weighing 16 6·2 lb., or 412 lb. per mile. The electric resistance at 60° Fahr. is 12·8 ohms, or 1,389 ohms per foot-grain; before breaking under a tensile strain its maximum elasticity was 15·5 per cent., and it stands 13·5 twists in 6 inches ere it breaks. No trace of galvanization is left. Of course it is impossible to determine from these imperfect data whether or not the wire has become more brittle in course of time, for though we may learn very accurately what its present strength and elasticity are, we do not know what the original values were. We are not, therefore, wholly warranted in concluding that in a strictly scientific sense there has been no molecular alteration in the wire; but we may safely conclude with Mr. Preece that, practically speaking, there has been none, and that for all the requirements of telegraphy the wire is as good, or almost as good, now as when it was put up. Indeed, when we reflect that the molecular dislocation observed by M. Planté is the result of violent electric disturbance transgressing the bounds of molecular stability so far that the molecules could not recover their old relations to each other, we are led to the opinion that any such brittleness need hardly be expected to make its appearance in telegraph wires, the limits of molecular resilience never being overstepped by the comparatively feeble currents. In telegraph wires the passage of the current may agitate the molecules, but it could hardly throw them out of joint.

Mr. Preece's paper was followed by a short but very interesting discussion bearing upon the subject of molecular changes in metals. Mr. J. B. Stearns, the inventor of the first practical duplex system of telegraphing on land lines, remarked that instrument makers found, curiously enough, that both brass and copper wire became brittle by simply lying in store, and without being traversed by currents at all. Mr. Stroh, the well-known electrical mechanician, corroborated this fact from his own experience, and further added that the deterioration was more marked when the wire lay in a room where there was gas. Mr. Preece also gave it as the result of long practical experience with telegraph wires in this country that they decayed in a few years near smoky towns or chemical works, whereas in the country they were practically indestructible. Valuable pictures, too, sometimes dropped from the walls owing to the snapping of the brass or copper wires by which they were hung. The most novel and important communication to the meeting was, however, the fact mentioned by Professor Hughes, that about a month ago he accidentally discovered that wires of iron or steel, after being dipped for a very short time, say two minutes, in a solution of sulphuric acid and water, become exceedingly brittle and will not bear bending. We have repeated this experiment and testify to the results. On immersing two steel needles for two minutes in acidulated water containing about one-tenth of sulphuric acid to nine-

tenths of water, the ends of the wires up to the point where the level of the liquid stood were found to be in a condition best expressed by the word "rotten," and they broke off short when an attempt was made to bend them on themselves with a pair of pincers. Professor Hughes has ascertained that the effect is not due to mere corrosion of the surface or "skin" of the metal, and Mr. Stroh, who has repeated his experiments, filed notches and made a rough surface on several pieces of wire which had not been immersed, without impairing their specific toughness. He also polished the surface of steel wires which had been immersed, and found them to break as easily as before. Mr. Stroh has further extended the experiments of Professor Hughes to nitric acid diluted with water, but to his surprise, although the wires immersed in this acid were similar to those immersed in the sulphuric acid, and their surfaces much corroded by chemical dissolution, no sign of rottenness could be detected. Mr. Chandler Roberts, chemist to the Mint, has suggested to Professor Hughes that this curious phenomenon is probably due to the absorption of hydrogen by the iron; and it is worthy of note that Professor Hughes is able to restore the wire to something like its old elasticity and strength by heating it to a cherry red in the flame of a spirit lamp. A second plunge into the liquid reproduces the rotten state. If the absorption of hydrogen hypothesis is true, the flame of the lamp, by expanding the metal and expelling the gas, would act in a manner similar to the electric incandescence employed by Mr. Edison in his experiments on the tempering of wires *in vacuo* by expulsion of the air particles which they contain. The fact, however, that nitric acid has no effect on the wires would seem to militate against the hydrogen hypothesis, since no hydrogen exists in that body. Be this as it may, the phenomenon is certainly an interesting one, and well worthy the attention of engineers, for in these days of iron structures nothing should be neglected which tends to throw light on the atomic wreck of that material.—*Engineering.*

PRELIMINARY NOTE ON MAGNETIC CIRCUITS IN DYNAMO AND MAGNETO ELECTRIC MACHINES.

By LORD ELPHINSTONE and CHARLES W. VINCENT, F.R.S.E., F C.S., F.I.C. Received July 26, 1879.

THE experiments which form the subject of the present note were made in connection with an investigation as to the best form for the construction of a dynamo-electric machine, intended to furnish currents of high intensity in great quantity. The principle deduced applies equally to magneto-electric machines.

The source of power in all dynamo-electric machines being electro-magnets whose cores are already slightly magnetic, it appeared to us necessary to consider the conditions under which the initial force of such machines is best obtained.

For this purpose we made use of a U electro-magnet having a core of soft iron 2 inches in diameter and 36 inches long. The arms of the U were 4 inches apart. The exciting helices were two sheet copper reels, 12 inches long, fitting closely upon the uprights of the U, but readily removable. Each of these reels was coiled with 200 yards of No. 14 double covered copper wire.

Two cores of soft iron, of the same diameter, and each 12¼ inches long, and which could be magnetized by the same helices, were also employed.

The principal armature was of soft iron, 8 inches in length, by 2 inches in width, and 1 inch thickness, rounded at the ends. Its face fitted approximately close to the poles of the U magnet, whose faces it completely covered when placed upon them.

Other armatures and magnets were employed, the form of which we propose to describe in a future paper.

The iron of which the U and the straight cores were made was found to be exceedingly plastic as regards molecular magnetic polarity. In a few seconds after the cessation of an electric current from twenty quart Bunsen cells acting through the above helices, they were incapable of attracting and holding even fine iron filings.

The U magnet tested with a suspended magnetic needle was found to retain some magnetic polarity after many days; in fact, it is doubtful if the magnetism ever entirely disappeared, except when the core was subjected to special treatment.

On the other hand, the straight cores lost their induced magnetism more rapidly, and when, having been demagnetized either by time or by the mode described further on, they were placed in the line of the magnetic dip, they showed poles in accordance therewith; and on reversing the position of the core, these poles were immediately reversed without its being necessary to resort to striking the bars or other means of putting them in a state of vibration. It was thus demonstrated to our minds that if iron of similar quality, and in this form, were made use of for the electro-magnet cores in the dynamo-electric machine, the initial force producing the electric currents of the machine could not be due to residual magnetism, but rather to the lines of magnetic force of the earth.

The current from four Bunsen cells sent round the U magnet fixed the armature so firmly that it could not be pulled, or even slid off, by the utmost exertion of one man's strength.

On breaking battery contact, if both poles were completely covered, a direct pull failed to separate armature and magnet. The armature could, however, though with difficulty, be slid off, the difficulty of movement greatly increasing as the edge of the poles was approached. For instance, on attempting to slide the armature off the north, the south, or both poles, the resistance became greater as the point of final communication between the poles through the moving armature was approached. This was found to be the case whatever time had passed between the rupture of contact and the first movement of the armature. (Sometimes many days elapsed.) In very many experiments it was found, moreover, that, provided neither pole had been completely uncovered, on sliding back the armature to its normal position, the magnet, which with its stand and coils weighed over 58 lb., could be lifted by it.

A current from four Bunsen cells, almost momentary in duration, sufficiently magnetized the core to produce all the above effects.

If, while the current flowed round the U magnet, the armature rested on one pole only, it was of course strongly held; but on breaking contact it was at once set free, and fell off if not unbalanced; the magnetism of the U core immediately falling to its minimum, as shown by suspended test needles. If, however, the most minute point of connection existed between the armature and the other pole, in addition to its complete contact with the one it covered, it continued to be firmly held long after battery contact was broken.

It being thought that possibly the effects described were partly due to molecular attraction of the iron atoms when brought into close contact under magnetic stress, the poles were coated with a layer of tallow, but if this was sufficiently thin, the magnet could still be lifted by the armature after breaking battery contact. When the tallow was broken into small lumps, allowing light to be seen between magnet and armature, the same result was obtained.

Thus absolute metallic contact was found to be unnecessary for the retention of a considerable amount of magnetism by the U core and its armature, when in magnetic circuit. With a piece of writing paper interposed between the poles and armature, they were held together with great force long after battery contact was broken; but when the distance was increased by the interposition of cards, nails, or wires, to one-sixteenth of an inch, the residual attractive force was very much lessened. When the magnetic circuit becomes more open the residual magnetism dies away in about the same proportion as the attractive force of core and armature, whilst under the influence of the battery current it becomes less when the distance between them is increased.

Interposition of thick glazed note paper caused such a diminution of the residual magnetism that the magnet could no longer be lifted by the armature.

The experiment was varied by putting lengths of fine silk thread straight across between the armature and the magnet; in this, as in the former experiments, the armature was firmly held, and the magnet could be lifted by it. There was no point of actual metallic contact, and light could be seen over both magnetic fields, except at the thin lines where the silk threads were. The 58 lb. magnet, when lifted by the armature, was thus literally suspended in the air (like Mahomet's coffin) by the magnetism remaining in the almost closed circuit, and this long after the exciting electric current had ceased. (The experiments were made at intervals of four hours, twenty-four hours, three days, four days; the armature had always ultimately to be wrenched off.)

The same result was obtained with plates or slips of zinc, copper, platinum, silver, and aluminum foils, gutta-percha tissue, embroidery, cotton, etc., and appeared to depend entirely on the distance between poles and armature, irrespective of the nature of the interposed body.

When the straight cores were placed on the poles of the U magnet, and a current passed round the latter, attraction ceased the moment the battery contact was broken; but if, while the current was passing, the armature was placed on the poles of the cores, the whole system was firmly held together, though the current no longer flowed.

There would appear to be no limit to the length of time during which the stored-up magnetic force exerts itself in such metallic circuits (closed, or nearly so) as are described above, for it was found that, after periods varying from one to fourteen days from the time of a momentary passage of an electric current round the cores, the attractive force was as great, or even greater, than at the first moment.

A small electro-magnet, U-shaped, with limbs 6 inches long, having a core of three-quarter inch iron, and helices consisting of 4 layers of No. 16 covered copper wire, had for its armature a similar U core uncoiled. The uncoiled U was hung up, and the electro-magnet held beneath it, the poles of each being opposed; a current from four Bunsen cells was then sent through the coils for a few seconds. Not only did the electro-magnet (weighing, with its coils, several pounds) remain firmly attached to its armature, but the hanging on to it subsequently of 8 pounds additional weight failed to detach it.

A further proof of the large amount of magnetism held captive in a circuit thus closed was afforded by the following experiments. On connecting the ends of the wires from the helices with a galvanometer and resistance coil, deflections varying from 40° to 90° were obtained with a resistance of 1,700 ohms in circuit each time the armature was forced away from the poles of the large U magnet, after the passage of a current from four cells of a few seconds' duration. By careful manipulation, sparks between the ends of the helix wires were also obtainable each time the closed magnetic circle was opened. (In one case a week had elapsed betwixt the passage of the current and obtaining of the spark.)

In all these experiments, when the circuit was completely closed there was no external magnetism apparent, but on slightly breaking contact between the poles and armature, magnetic poles could be detected. Slight irregularities of the surfaces in contact likewise caused the development of poles.

A heavy magnetic needle, 4 feet distant from the magnet, if deflected by the U magnet, uncovered by its armature, 45°, would fall back to 5° when the current ceased. If the poles were now covered by the armature, the needle went to 0°. Passage of the current from four cells would now give a deflection of about 38°; on the current ceasing the needle would come back to 0°, and rise again to 5° on removal of the armature; but if, instead of immediately pulling off the armature, the two ends of the wires of the helices were connected together, and then the armature was forced off, the needle would swing 20° and fall back to 5° very slowly (in about fifteen minutes).

If both poles of the U magnet were caused to be of the same name, and the armature placed upon them, there was no attraction after breaking battery contact.

The straight cores, if placed upon the U magnet connected by the armature, and then magnetized in such a way that the poles of the cores faced like poles of the U magnet, retained no magnetic polarity when taken away from the system, whereas when they formed part of such a closed circuit as we have above described, the bars retained sufficient polarity to affect a magnetic needle for some time.

We may here remark that the attractive force of electro-magnets for each other, in what we call open circuit, is not nearly as great as in a closed circuit. For instance, the U magnet could not be lifted by the straight cores placed upon its poles, even with a current from six Bunsen cells running round the helices; but on bridging the circuit with the armature the whole mass, weighing 82 lb., could be raised from the ground with the current of only two cells, and quite irrespective of the position of the exciting helices, whether both were on the magnet, both on the cores, or one on the magnet and one on a core.

From the foregoing experiments it appears clear that the more near the approach to a closed magnetic circuit, the stronger is the field of force, and the longer is retained the magnetism of the mass or masses of iron constituting the circuit. The same rule holds good with regard to permanent magnets. In closed circuits the attractive force is at its height, and diminishes in intensity as the magnetic field is more extended. But the parallel goes beyond this, for the more open the magnetic field, the more rapidly is the magnetic force itself dissipated.

These principles have guided us in the construction of a dynamo-electric machine of whose magnetic circuits we hope to describe more fully in a future paper.

In this dynamo-electric machine six fixed electro-magnets are used, having alternate poles, opposite to which, and at a very short distance, are placed three other electro-magnets so arranged with opposing poles as to form three nearly closed circuits. Coils of wire are made to revolve so as to cross the intervals between these opposing poles, and the electric currents induced in the moving coils are made to pass round the electro-magnets.

ON MAGNETIC CIRCUITS IN DYNAMO AND MAGNETO ELECTRIC MACHINES.—No. 2.

By LORD ELPHINSTONE and CHARLES W. VINCENT, F.R.S.E., F.C.S., F.I.C. Communicated by Professor G. G. STOKES, Sec. R.S. Received March 10, 1880. Read March 18.

A LARGE amount of magnetism is retained by the soft iron cores of electro-magnets, when arranged so as to form a complete magnetic circuit; and sparks and other indications of the passage of an electric current can be obtained at the ends of the helix wires surrounding those soft iron cores, each time the masses of iron are separated and the closed magnetic circuit opened. In order to procure a spark the breaking of the circuit must be effected suddenly, either by a jerk, tilt, or sliding movement.

In the case of the 58 lb. magnet described in our former note, the current that is capable of causing a spark, although only momentary in duration, is found to be sufficient in quantity and intensity to magnetize a small electro-magnet, weighing with its coils between 5 and 6 lb., enabling it to sustain its own weight for any indefinite time when suspended by its armature.

When the armature of the small magnet is placed at the distance of one-eighth of an inch from its poles, in such a manner as to be free to move, the instant the armature of the large magnet is suddenly tilted or slid off it darts to them, the completion of the circuit of the small magnet being signaled by a smart click. The rupture of one closed magnetic circuit is thus caused to produce another closed magnetic circuit.

But when the interval between armature and magnet, whose circuit it was intended to close, exceeded one-quarter of an inch, the former was not attracted with sufficient force to overcome the friction of the table upon which it was resting.

The mode of removing the armature from the large magnet appeared to be of no moment, but the time occupied by the removal had much influence upon the amount of magnetic force manifested in the smaller circuit. This was particularly the case if there were an interval, no matter how small, between the armature and the poles of the magnet round which the electric current was sent.

For example, if with an interval of one-sixteenth of an inch between the armature and the poles of the small magnet, the armature of the large magnet was slowly slid off, the magnetization of the small magnet never rose to a sufficient intensity to draw its keeper to itself, whereas, when the sliding took place rapidly, the small armature was strongly attracted as above mentioned.

The largest amount of magnetization was bestowed upon the small electro-magnet by the interaction when it was held upright, its poles being completely covered by a closely fitting armature. And it was also found that when thus set up in preparation for the formation of a closed magnetic circuit, the magnetization was produced by a much slower motion of the large armature than when the small magnet had its circuit partly open. When the circuit was completely closed, if the large armature were twisted off by a slow equable motion, in such a manner that both poles were uncovered at the same time, then the small magnet could be made to sustain not only its own weight (between 5 and 6 lb.) but an additional 3 lb. also.

During the passage of the electric current, obtained by the forcing open of the closed circuit, the fall of magnetism in the large magnet itself is checked, the direction of magnetic polarity remaining unchanged, the current checking or opposing the fall being in the same direction as that from the battery which caused the primary magnetization. If the ends of the helix wires are not connected together this effect is not obtained.

Electric currents, though of less intensity and quantity, can be produced in the helices of electro-magnets, without altogether breaking up the closed magnetic circuits. For instance, with the 58 lb. electro-magnet, the circuit being completely closed by its armature, and the helices being connected with a galvanometer, a very slight pull applied to the armature produces a current of electricity giving a considerable deflection of the needle in the same direction as the battery current; and the stronger the pull the greater the deflection of the galvanometer needle, up to the point at which the magnet is lifted from the ground, after which no further motion of the needle is produced, unless the magnet is subjected to additional strain. Thus, hanging a 4 lb. weight upon the uplifted magnet produced deflections in the same direction as the pull on the armature, and on removal of the weight produced reverse deflections.

Trying the same set of experiments with a very small electro-magnet, so that we might proceed to absolute rupture of the closed magnetic circuit without danger to the galvanometer, we found that the addition of successive weights to the magnet while hanging suspended by its armature, produced successive deflections of the galvanometer, the needle coming to rest at zero after each addition, as in the case of the large magnet.

When the maximum weight which the magnet was capable of sustaining was reached, and a real movement of the armature commenced, the induced current in the helix of the electro-magnet was very greatly increased by the addition of even the smallest weight.

From these experiments it may be inferred that in like manner as the passage of an electric current round a bar of iron produces elongation of the bar, so the elongation of the bar produces in its turn an electric current in the helix; and this current tends to strengthen the magnetization, and also that a magnet is absolutely stronger under tension than when at rest.

On the other hand, pressure on the armature, either continuous or sudden and momentary (a blow for example), causes an electric current in the helices in the opposite direction to original magnetization, or in other words, against magnetization, tending thereby to weaken the power of the magnet.

The 58 lb. magnet in closed circuit was hung by its armature, and on afterwards connecting its helices with the gal-

vanometer no current could be detected, but on lowering it until it rested with its whole weight on the ground a current in the direction of demagnetization was produced, giving a deflection of 15°. In the same way a current in the direction of magnetization was obtained, giving a deflection of 15°, by the application of sufficient strain to lift the magnet off the ground, and this result was invariable. The degree of swing, however, depended upon the rapidity with which the magnet was either raised or lowered.

It may be remarked that whereas any very slight application of force by pulling on the armature was sufficient to cause a current in the helices giving a deflection of 5° to 10° of the galvanometer needle, a great amount of pressure is necessary to produce a similar deflection. A slight pull with the finger and thumb in the one case was equal to the pressure of a hundredweight in the other.

By the momentary removal of the armature, the closed magnetic circuit is broken, and though by its immediate restoration a new closed circuit is formed, nevertheless the tension on the molecules of iron by the magnetic stress is very greatly reduced. Under these conditions a very slight pressure upon the armature produces a great swing of the needle, while a pull produces scarcely any effect at all until actual movement of the armature takes place.

If the pressure on the armature is great and continuous, a point is soon reached at which a slight pressure is no longer effective.

The effects produced are somewhat different if pressure is applied unequally. For instance: A weight of 7 lb. placed on the armature over the north pole of the 58 lb. magnet caused a current in the helices giving a deflection of 20° at the galvanometer. The same weight on the south pole gave the same deflection in the opposite direction. Pressure with the hand produced like swings of the needle proportionate to the force used, and the amount of swing can be easily controlled, and the needle brought to rest by judicious pressure on either pole of the magnet.

If a lateral pressure be applied to one side of the armature between the poles, and the needle swings, say, 5°, on removal of the pressure, a current is produced in the opposite direction, and the reverse swing, in place of being 5° will be 8°, and so on in proportion to the amount of force made use of.

None of the above-mentioned effects could be shown with the small magnets under pressure; and it was not found possible to produce a recognizable current without actual movement of the armatures.

Under certain circumstances the attractive force of electro-magnets in closed magnetic circuit is found to increase with lapse of time. For example: A small U-shaped electro-magnet with limbs 6 inches long, having a core of three-quarter inch iron, and helices consisting of four layers of No. 16 covered copper wire, when excited by four Bunsen cells, supported as an armature a similar U-shaped iron bar, but without a helix upon it, this latter remained firmly attached after the voltaic current had ceased, but the hanging on to it of an additional weight of 3 lb. 6 oz. instantly wrenched it away from the electro-magnet, and broke the closed magnetic circuit.

The magnet was then re-excited, the armature being fixed to the electro-magnet by being held in contact with the poles while an electric current, of a few seconds' duration, passed through the circulating wire. In place of immediately attempting to add any additional weight, the two iron U's were left hanging face to face, in the form of the link of a chain, for twenty-four hours, at the end of which time the weight of 3 lb. 6 oz. was hung on and sustained. Forty-eight hours later, an additional weight of 3 lb. 10 oz. was carefully added, making in all 7 lb. sustained. Twelve hours afterward 1 lb. more was added, bringing up the entire weight to 8 lb. beyond that of the armature; this was suffered to remain for five days, when the system was taken to pieces.

On a subsequent occasion the same magnet sustained an entire weight of 10 lb. beyond that of the U-shaped armature, the weight sustained being reached by beginning with an amount well within the sustaining power of the electro-magnet wire in closed circuit, and increasing it by small additions made with intervening intervals of time varying from twelve hours to several days.

Another and smaller U magnet was likewise experimented on; this weighed with its coils 3 lb. 6 oz. Its armature was a strip of soft iron, completely covering the poles, and having a hook in the center to which weights could be easily attached.

This electro-magnet was excited by the passage, for a few seconds, of the current from two one-pint bichromate cells. On breaking battery contact, the armatures failed to sustain 4 lb. The electric current was again sent round the electro-magnet, and the armature was pressed against the poles, being carefully adjusted so as to cover them completely, and at the same time to place the hook precisely in the center, so that the pull should be fair and equal when a weight was hung upon it. By this careful manipulation, on breaking contact with the bichromate cells, the closed magnetic circuit was found capable of sustaining the 4 lb. weight.

By successive additions of 2 oz. weights, made at intervals of a few minutes, the weight hanging to the armature was raised to 5 lb., after which the attempted addition of 2 oz. caused the disruption of the system.

The experiment was repeated under similar conditions, but with slightly extended intervals of time between the additions of the 2 oz. weights. The magnet in closed circuit was made to hold 4 lb., 4¼ lb., 4½ lb., 4 lb. 14 oz., 5 lb. 2 oz., the time taken in all, for the successive additions, being ten minutes. The system was then left for twelve hours, when by additions of 4 oz. at intervals of a few minutes the weight sustained was increased to 6 lb. 4 oz. Eleven hours later, this was further increased to 7 lb. 6 oz., and two hours afterwards to 8 lb. 2 oz.

A still smaller electro-magnet, weighing with its coils 5 oz., and having an armature consisting of a very thin slip of soft iron, when excited by one of the bichromate cells, could not be made when in closed circuit to sustain 1½ lb. at the moment of breaking the voltaic circuit. It, however, sustained 1 lb. with ease. The latter weight was therefore suspended, and the cell wires removed after the closed magnetic circuit was completed. By successive additions of 2 oz. weights at short intervals of time (five minutes to ten minutes each), this small magnet could be made to sustain 2 lb. 2 oz., but the addition of 1 oz beyond this weight at once separated the armature and magnet. It was thought that a longer interval of time should, as in the former instances, enable the magnet to sustain a still greater weight. It was therefore brought into closed circuit, as before, and made to sustain 2 lb. 2 oz. in the manner just related, and was thus left for twelve hours. Successive additions of 2 oz. were then made to the hanging weight until it reached 2 lb. 14 oz. Twenty-four hours afterwards, 4 oz. more were added, bringing the entire weight suspended to 50 oz.

This small soft iron magnet, which, at the instant the voltaic current was withdrawn, was totally unable to sustain five times its own weight, was thus by gradual growth of its magnetic force enabled to hold ten times its own weight.

In the course of these experiments it was remarked that the longer the period the soft iron remained in closed magnetic circuit the more magnetically ductile did its molecules appear to become. An electro-magnet, which had been for a few days in closed circuit, could after rupture of the circuit be made to sustain weights in a fresh closed circuit at much shorter intervals of time than if it was magnetized, after being for some time with its poles uncovered. The direction of the battery current with reference to the residual magnetism of the electro-magnets appeared to be of no moment. A magnet which had been left for some time with its poles uncovered had less residual magnetism after a momentary current had passed through its helices, than another magnet which had been in active closed circuit, even if the battery current had, in the latter case, to overcome a considerable amount of residual magnetism.

We found, moreover, that soft iron magnets retain their residual magnetism longer, and are capable of acquiring increased magnetization much more rapidly after having been bearing weights (thereby keeping the iron in a state of strain), than if they have been left in their normal condition and without bearing any weight at all.

The conditions under which the closed magnetic circuit retains its force are not yet clearly established.

With the 58 lb. magnet a succession of gentle taps struck vertically with a wooden mallet upon the center of the armature, while resting on the magnet in closed circuit, in a very few moments completely dissipated the magnetic force so far as the sustaining power of the magnet was concerned.

Removal of any portion of the weight suspended to the armature of a magnet hung up in closed circuit likewise tends to dissipate the force of the circuit. For example: Half an hour after the removal of a weight of 10 lb., which had been suspended to the armature of a U magnet for twenty-one days, the armature fell off on receiving a slight touch. In another experiment, a U magnet, which was capable of sustaining 7 lb. and which had actually been suspending 4 lb., was left for two months with the armature on only, the weight having been removed; at the end of that time a very slight shake was sufficient to cause the armature to fall off. Many other examples might be quoted to show that release from strain diminishes the magnetic force of the circuit.

In these experiments, in which the closed magnetic circuits had given way, the soft iron had been in a state of strain from which it had been released by the removal of the suspended weights. But when no weights were hung upon the armature, and the iron had never been in a state of magnetic tension, the closed magnetic circuit so far from diminishing, increased in force. The 58 lb. magnet was excited with a voltaic current so feeble, that although the magnet could be lifted by the armature in closed circuit, yet great care was necessary that the lift should be exactly vertical; and very little force was required to slide the armature off the poles. After the lapse of a month the armature was so firmly held that the utmost exertion of manual force could not stir it by a sliding movement, and the whole magnet could be raised from the ground even if tilted as much as 15° from the perpendicular.

The magnetism of the closed circuit of the 58 lb. magnet disappears after repeated up and down movements of either one or both of its helices, provided the ends of the helix wires are connected together either singly in two separate circuits, or together in one continuous circuit. Every up or down movement of either of the helices produces currents in the wires either for or against magnetization, which currents apparently so disturb the molecules of the iron that the fixity of their original magnetic direction is lost.

In like manner as the movements of the armature, or the increased or diminished tension of the iron, produce currents of electricity in the helix wires surrounding the magnets, so the movements of the helices produce currents of electricity which may either magnetize or demagnetize the iron. With the 58 lb. magnet in closed circuit, the two ends of one of the helices being connected to the galvanometer, and the two ends of the other helix being connected with each other, the latter helix is moved towards the armature, a current is produced in the galvanometer helix which shows a fall of magnetization. On moving the same helix away from the armature, a current is produced in the direction of magnetization.

In another experiment 30 yards of No. 16 covered copper wire, with its ends connected together, and so coiled that it could be moved freely from pole to pole over the armature, was placed on one limb of the 58 lb. magnet and the closed circuit established. Both helices were then brought into continuous circuit through the galvanometer.

On movement of the coil of wire from south limb to the north limb of the magnet, a current was produced showing an increase of magnetization. On moving the coil in the opposite direction, *i. e.*, over the north limb pole, and on to the south one, the current is reversed, and is in a direction which would cause demagnetization.

It appears, therefore, that any interference with the lines of force about a magnetic circuit means an interference with the magnetic circuit itself, and points to the possibility of building up magnetic force of magnets by the mere movement of wires in these lines of force, though the coils moved need not of necessity be connected with the helices surrounding the magnets.

THE TEMPERATURE OF SPACE AND ITS BEARING ON TERRESTRIAL PHYSICS.

FEW questions bearing directly on terrestrial physics have been so much overlooked as that of the temperature of stellar space, that is to say, the temperature which a thermometer would indicate if placed at the outer limits of our atmosphere and exposed to no other influence than that of radiation from the stars. Were we asked what was probably the mid-winter temperature of our island 11,700 years ago, when the winter solstice was in aphelion, we could not tell unless we knew the temperature of space. Again, without a knowledge of the temperature of space, it could not be ascertained how much the temperature of the North Atlantic and the air over it were affected by the Gulf Stream. We can determine the quantity of heat conveyed into the Atlantic by the stream, and compare it with the amount received by that area directly from the sun, but this alone does not enable us to say how much the temperature is raised by the heat conveyed. We know that the basin of the North Atlantic receives from the Gulf Stream a quantity of heat equal to about one-fourth that received from the sun, but unless we know the temperature of space we cannot say how much this one-fourth raises the temperature of the Atlantic. Suppose 56° to be the temperature of that ocean: this is 517° of absolute temperature which is derived from three sources, viz: (1) direct heat from the sun, (2) heat from the Gulf Stream, and (3) heat from the stars. Now, unless we know what proportion the heat of the stars bears to that of the sun, we have no means of knowing how much of the 517° is due to the stars and how much to the sun or to the Gulf Stream.

M. Pouillet and Sir John Herschel are the only physicists who appear to have devoted attention to the problem. The former came to the conclusion that space has a temperature of —142° C. or —224° F., and the latter, following a different method of inquiry, arrived at nearly the same result, viz., that its temperature is about —239° F.

Can space, however, really have so high a temperature as —230°? Absolute zero is —461°. Space in this case would have an absolute temperature of 222°, and consequently our globe would be nearly as much indebted to the stars as to the sun for its heat. If so, space must be enormously more transparent to heat rays than to light rays. If the heat of the stars be as feeble as their light, space cannot be much above absolute zero, and this is the opinion expressed to me a few weeks ago by one of the most eminent physicists of the day. Prof. Langley is also of this opinion, for he concludes that the amount of heat received from the sun is to that derived from space as much as four to one; and consequently if our luminary were extinguished the temperature of our earth would fall to about —360° F.

It must be borne in mind that Pouillet's Memoir was written more than forty years ago, when the data available for the elucidating the subject were far more imperfect than now, especially as regards the influence of the atmosphere on radiant heat. For example, Pouillet comes to the conclusion that, owing to the fact of our atmosphere being less diathermanous to radiation from the earth than to radiation from the sun and the stars, were the sun extinguished the radiation of the stars would still maintain the surface of our globe at —89° C., or about 53° C. above that of space. The experiments of Tyndall, however, show that the absorbing power of the atmosphere for heat-rays is due almost exclusively to the small quantity of aqueous vapor which it contains. It is, evident, therefore, that but for the sun there would probably be no aqueous vapor, and consequently nothing to protect the earth from losing its heat by radiation. Deprived of solar heat, the surface of the ground would sink to about as low a temperature as that of stellar space, whatever that temperature may actually be.

But before we are able to answer the foregoing questions, and tell, for example, how much a given increase or decrease in the *quantity* of sun's heat will raise or lower the *temperature*, there is another physical point to be determined, on which a considerable amount of uncertainty still exists. We must know in what way the temperature varies with the amount of heat received. In computing, say, the rise of temperature resulting from a great increase in the quantity of heat received, should we assume with Newton that it is proportional to the increase in the quantity of heat received, or should we adopt Dulong's and Petit's formula?

In estimating the extent to which the temperature of the air would be affected by a change in the sun's distance, I have hitherto adopted the former mode. This probably makes the change of temperature too great, while Dulong's and Petit's formula adopted by Mr. Hill (*Nature*, vol. xx., p. 626), on the other hand, makes it too small. Dulong's and Petit's formula is an empirical one, which has been found to agree pretty closely with observation within ordinary limits, but we have no reason to assume that it will hold equally correct when applied to that of space, any more than we have to infer that it will do so in reference to temperature as high as that of the sun. When applied to determine the temperature of the sun from his rate of radiation, it completely breaks down, for it is found to give only a temperature of 2,130° F. (*Amer. Jour. Science*, July, 1870), or not much above that of an ordinary furnace.

But besides all this it is doubtful if it will hold true in the case of gases. From the experiments of Prof. Balfour Stewart (*Trans.* Edin. Roy. Soc., xxii.) on the radiation of glass plates of various thicknesses, it would seem to follow that the radiation of a material particle is probably proportionate to its absolute temperature, or, in other words, that it obeys Newton's law. Prof. Balfour Stewart found that the radiation of a thick plate of glass increases more rapidly than that of a thin plate as the temperature rises, and that, if we go on continually diminishing the thickness of the plate whose radiation at different temperatures we are ascertaining, we find that, as it grows thinner and thinner, the rate at which it radiates its heat as its temperature rises becomes less and less. In other words, as the plate grows thinner its rate of radiation becomes more and more proportionate to its absolute temperature. And we can hardly resist the conviction that if it were possible to go on diminishing the thickness of the plate till we reached a film so thin as to embrace but only one particle in its thickness, its rate of radiation would be proportionate to its temperature, or in other words, it would obey Newton's law. Prof. Balfour Stewart's explanation is this: As all substances are more diathermanous for heat of high than low temperatures, when a body is at a low temperature only the exterior particles supply the radiation, the heat from the interior particles being all stopped by the exterior ones, while at a high temperature part of the heat from the interior is allowed to pass, thereby swelling the total radiation. But as the plate becomes thinner and thinner, the obstructions to interior radiation become less and less, and as these obstructions are greater for radiation at low than high temperatures, it necessarily follows that, by reducing the thickness of the plate, we assist radiation at low more than at high temperatures.

If this be the true explanation why the radiation of bodies deviates from Newton's law, it should follow that in the case of gases, where the particles stand at a considerable distance from one another, the obstruction to interior radiation must be far less than in a solid, and consequently that the rate at which a gas radiates its heat as its temperature rises, must increase more slowly than that of a solid substance. In other words, in the case of a gas, the rate of radiation must correspond more nearly to the absolute temperature than in that of a solid; and the less the density and volume of a gas, the more nearly will its rate of radiation agree with Newton's law. The obstruction to interior radiation into space must diminish as we ascend in the atmosphere, at the outer limits of which, where there is no obstruction, the rate of radiation should be pretty nearly proportional to the absolute temperature. May not this to a

certain extent be the cause why the temperature of the air diminishes as we ascend?

If the forgoing considerations be correct, it ought to follow that a reduction in the amount of heat received from the sun, owing to an increase of his distance, should tend to produce a greater lowering effect on the temperature of the air than it does on the temperature of the solid ground. Taking, therefore, into consideration the fact that space has probably a lower temperature than −239°, and that the temperature of our climate is determined by the temperature of the air, it will follow that the error of assuming that the decrease of temperature is proportional to the decrease in the intensity of the sun's heat may not be great.

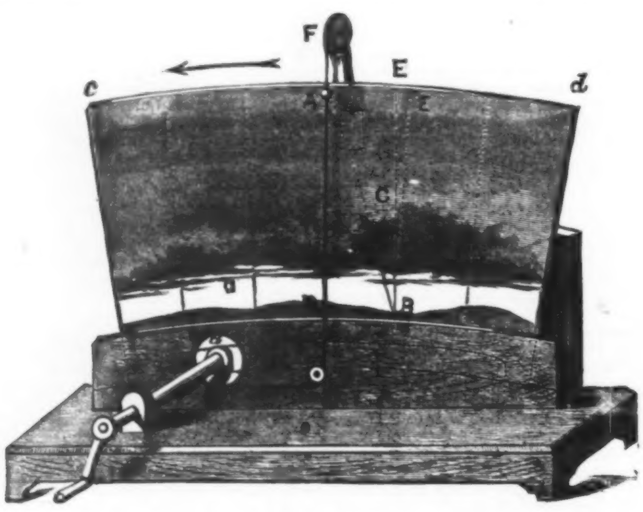
In estimating the extent to which the winter temperature is lowered by a great increase in the sun's distance there is another circumstance which must be taken into account. The lowering of the temperature tends to diminish the amount of aqueous vapor contained in the air, and this in turn tends to lower the temperature by allowing the air to throw off its heat more freely into space.—*James Croll, in Nature.*

APPARATUS FOR ILLUSTRATING "THE ABERRATION OF LIGHT."

By THOMAS WILLIAM TOBIN, Professor of Chemistry and Physics, Central University, Richmond, Ky.

AMONG the many appliances of the modern physical laboratory for the illustration or explanation of natural phenomena, I do not know of any specially devoted to that somewhat complex yet beautiful principle, the "aberration of light." The illustration of "a projected stone passing through a railroad car while in motion" is one only of comparison, and does not present satisfactorily the actual phenomenon to the mind of a student. With this fact in view, I constructed a piece of simple mechanism, which is actually a model of the reality, and the experiment having proved successful, I herewith append a description of it for general use:

The construction will be easily understood by reference to the accompanying diagram: *c d* is a movable disk in connection with the pinion, *a*; *b* is a grooved wheel on the same axle as the pinion, attached to which is a silk cord passing over the fixed pulleys, *f* and F, thence to a counterweight at the back of the disk, *c d*; A is a silvered glass bead on the silk cord; the whole is mounted on a stand, *e*.



In the year 1725 Dr. Bradley, while making observations upon the fixed stars, with a view of finding parallax and distance, discovered the displacement of their images in the heavens. He explained in a satisfactory manner the cause in the aberration of light. By subsequent minute observations upon the character of the phenomena, this aberration was accounted for by the progressive motion of light, which he thus found to be 192,600 miles per second.

Römer, the Danish astronomer, had, some 50 years previously, also in an unexpected manner, determined the velocity of light, by observations of Jupiter's satellites, to be 192,000 miles per second.

Now, the apparatus already described is intended to explain how this velocity by Bradley was ascertained. Suppose the observer to be stationed at B, and the earth stationary in space; the image of a star, a little to the left of the zenith, coming in the direction E B would enter his telescope in that line. The velocity with which the image entered, great or small, would not affect the direction of the line of sight. Let now the image of a star at A be represented by the silvered bead, having a velocity, A D, per second of time; in other words, let the distance, A D, represent the velocity of light per second. While the image would appear in the line, A D, to an observer at D, if the earth were stationary, a very different result presents itself to the observer at B, when the earth has motion in the direction B D. Now, we will take B D to represent the velocity of the earth's motion in space during one second, and the mechanism of the apparatus will then show the progressive motion of the image, A, toward the observer at B; it will follow the dotted line, A B. The arc at C represents the angle of displacement or aberration.

The problem of Dr. Bradley may be now easily stated: D B, the motion of earth in space, was known; the arc, C, he ascertained by observation to be 20 seconds; the line, A D, representing the velocity of light, he calculated by simple trigonometry to be 192,600 miles. It was one of the most interesting and important astronomical discoveries ever made, and confirmed Römer's previous discovery of the progressive motion of light.—*Journal Franklin Institute.*

POSTAL STAMPS.

A EUROPEAN paper states that there have been issued, the world over, as many as six thousand different kinds of postage stamps. Among them are to be found the effigies of five emperors, eighteen kings, three queens, one grand duke, six princes, one princess, and a great number of presidents, etc. Some of the stamps bear coats of arms and other emblems, as crowns, the papal keys and tiara, anchors, eagles, lions, horses, stars, serpents, railway trains, horsemen, messengers, &c. The collection preserved in the Museum of the Berlin Post-offices included, on July 1, 1879, 4,498 specimens of different postage stamps.

IMPROVEMENT IN MICROSCOPIC EYE-PIECES.

By J. H. WYTHE, M.D.

THE magnifying power of microscopic objectives depends on the diameter of the cone of rays at the upper part of the tube of the instrument. As in Fig. 1, the cone of rays from an objective of short focal length is much wider at the base than the cone from one whose focal length is larger, as in Fig. 2.

The diameter of such a cone may be increased by using a concave lens, or meniscus, which produces still greater divergence, as in Fig. 3.

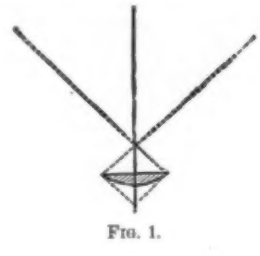


FIG. 1.

If this diverging lens be made achromatic, no injurious effect can happen to the image formed by the objective save the loss of light consequent on enlargement. Even a non-achromatic concave lens or meniscus may be usefully employed to amplify the image so that an objective of low power may be made to magnify an object as much as one of shorter focal length. Theoretically, a perfectly achromatic amplifier is needed, but practically one not achromatic is quite useful. The degree of amplification depends on the concavity of the amplifier, its nearness to the objective, the length of the tube, and the power of the eye-piece used to concentrate and magnify again the image produced.

The diameter of the microscope tube has an important relation to the distinctness and luminosity of the image. Few tubes are wide enough to utilize more than a small proportion of the rays proceeding from an objective. The field glass of the eye-piece should be of the greatest diameter possible for its focal length, and the tube wide enough to receive it, in order to concentrate the greatest number of rays from the objective. The short tubes of French and German microscopes are supplied with narrow eye-pieces, which cut the cone of rays nearer the objective and give a more brilliant image than would be possible in a longer tube. If the tube be longer, it must also be wider, and the eye-piece of corresponding diameter.

In considering the construction of the microscope with a view to greater amplification by the eye-piece, it occurred to me that the concave lens or meniscus used to diverge the rays of the objective should form a part of the eye-piece and be of as large diameter as the tube will allow. If it be of small diameter, it must be placed nearer the objective. This is the form and position of the amplifiers of Tolles, Zentmayer, and others.

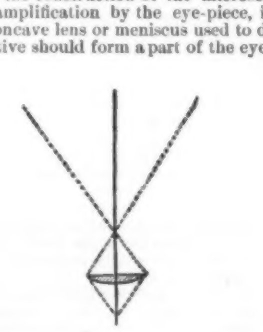


FIG. 2.

One of the amplifiers exhibited by me to the San Francisco Microscopical Society, on a previous occasion, consists of a conical meniscus (Fig. 4), whose position in the tube and effects correspond with the amplifiers above-named. With this simple addition placed in the lower end of the draw tube, the magnifying power of an objective can be nearly doubled with little loss of light or of definition.

The other form of amplifier exhibited is still better. A double concave lens or meniscus, of as great diameter as the tube will allow and of considerable diverging power, is placed at a distance of from two to four inches in front of the eye-piece. In the improved form in which I now present it, a concave meniscus of six inches equivalent focus and one and a half inches diameter (which formerly served as part of the object-glass of a small telescope, is placed in a draw tube at the end next the eye-piece and about three inches from the latter. To counteract the aberration of the amplifier, I have sometimes substituted for the plano-convex field glass of the Huyghenian eye-piece a convex meniscus of short focus, which gives also a very wide and flat field of view. Ordinary eye-pieces and the periscopic eye-pieces of Gundlach may also be used with the amplifier. The amplifying eye-piec, thus constructed, has given me great satisfaction. If the concave meniscus were made achromatic it would doubtless be a still further improvement, yet the performance of the eye-piece leaves little to be desired. The wavy, basket-like, longitudinal striæ on *Surirella gemma* and the hexagons on *P. angulatum* are well seen with a one-fourth objective, and the *Frustulia Saxonica* and *A. pellucida* (dry) have been resolved by it with a non-adjusting one-eighth of Gundlach's.

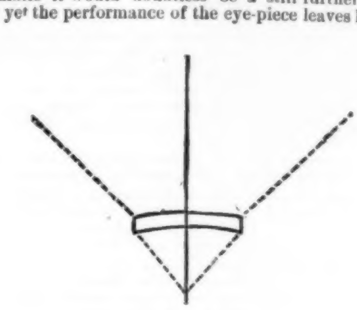


FIG. 3.

In place of the concave meniscus referred to, I have also used, with nearly as good effects, a double concave lens of two or three inches equivalent focus, such as can be obtained at an opticians for about fifty cents. So that by a very small cost of time and money the possessor of an ordinary objective may increase the power of his instrument to a very great degree.

FIG. 4.

I reiterate the conviction before expressed, that further improvement of the microscope may be looked for in the construction of eye-pieces, regulating their magnifying power and increasing their diameter so as to concentrate rays from the objective which are now absorbed by the sides of the tube.—*Mining and Sci. Press.*

A MAN STRUCK BY LIGHTNING.

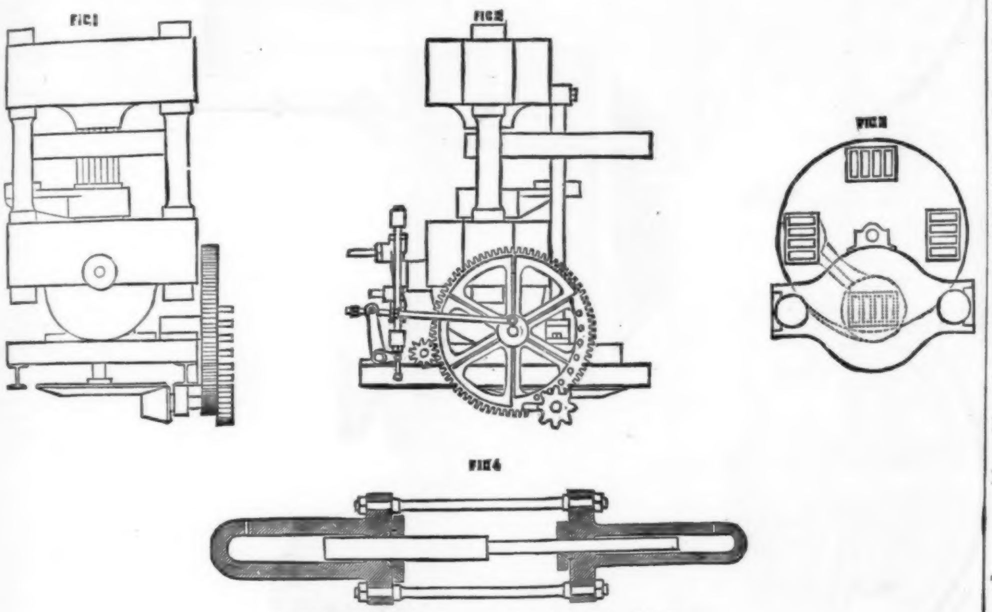
DR. G. WILKS (Ashford) contributed this case. On June 8 last, four men at work in Romney Marsh were compelled by the violence of the rain to seek shelter. Three of them retired into a lodge; the fourth (J. Orman) remaining under a willow-tree by the window of the lodge to pass urine. Almost instantaneously, the building was enveloped in a blaze of lightning. The three occupants, having recovered from their terror, ran to seek their companion. They saw that the tree had been struck, that Orman's boots lay at the foot of the tree, and his clothes scattered in a line for several yards along the field, while he himself was stretched upon his back six feet away, stark naked, calling to them for aid. The man himself said that he felt himself violently struck across the chest and shoulders, hurled through the air, and dashed upon the ground, and was sure that he never lost consciousness. His clothes were all blown off him, except one sleeve of his flannel under-vest; the leather straps which fastened his trowsers were rent like tinder, and his new strong boots torn like paper, while his watch and chain was partly fused. Upon admission to the Ashford Cottage Hospital, the man was found to be burnt all over, more or less; his eyebrows and whiskers were gone; the burns on the back and chest were superficial, those on the abdomen and pubes more deep; down each leg ran a broad three-inch ribbon-like scar, terminating at the left heel in a small roundish hole; at the right, in a large lacerated wound, through which the os calcis might be felt fractured into several pieces. There was also a compound comminuted fracture of the right tibia and fibula, which bones were protruding through the skin in the course of the ribbon-like burn. The deepest burns were about where the buckles of the waist-belt and garters and the watch must have been; but from the knee to the heel on the right leg, the whole thickness of the skin in the ribbon-like track was destroyed by the burning. The man was deaf, but singularly placid and cheerful, showing no signs of shock. He made an excellent recovery (though the burns about the fractures, and the sloughy state of the heel, were complications of some moment), walking across the room ten weeks after the accident. He was now (October) earning his living, with a leg shortened from a half to three quarters of an inch. The following facts were noted: 1. The course of the electrical action was from above downward; 2. The clothes being very wet, their conductivity had been probably heightened; 3. Where the flannel was next the skin, the burns were more superficial; 4. Where the cotton shirt and trowsers touched him, the burns were uniformly deeper; 5. Wherever there had been a piece of metal (*e.g.*, waist-belt, jacket-buckles, watch, shoes), there had been an explosion, or at least a development of great heat; 6. The man was aware that he usually raised his right heel from the ground during micturition, which might have caused the fierce explosion on that side; 7. The nervous system had an almost complete immunity from injury. This was attributed to the wet clothes being good conductors.

Sir James Paget has held possession of the clothes (exhibited) for some weeks; seeing them, he felt sure that any one would conceive it impossible that a flash of lightning could do what had been done in the case. He considered the explanation of the man's preservation from instant death, as given by Dr. Wilks, the correct one—as being due to the dampness of the clothes in contact with the body. The course taken by the lightning flash was worthy of note, as showing the possibility it had of completely stripping the body by clean sweeps. The irregularities in the direction of the rents were to be attributed to interference with the direct passage of the current by dry patches of clothing. This was particularly noticeable in the boots, one of which, at the time of the accident partially raised from the ground, was

much more irregularly injured than the other. The watch exhibited proof of the same peculiarity. Sir James further added that, in a tree close by the place where the man was, there remained marks to show that the flash had pursued a path down the moist *liber* of the trunk. He considered the man had been excellently treated by Dr. Wilks. Dr. Broadbent suggested that the stripping of the body might be explained on the assumption that a body of steam had been rapidly formed, and that its explosive force had stripped the man. Dr. Althaus remembered reading of a similar case twenty-one years ago, recorded in the *Philosophical Transactions*. He attributed the effects produced by electricity to the mechanical force merely of the discharge, which was very great. He could not but think it strange that the man exhibited no paralysis or affection of the nerve-centers. Possibly the man was a bad conductor of electricity.—*British Medical Journal.*

HYDRAULIC ACCUMULATOR.

THE apparatus we are about to describe is designed as an adjunct to a hydraulic ram or press. It is called by the inventors, Messrs. S. J. Best and W. J. Marshall, of London, a "Differential Accumulator," and consists essentially of two cylinders fitted with rams; the proportion of difference between the diameters of the rams being dependent upon the amount of pressure required to be obtained. The rams of the two cylinders of the accumulator are connected together by rods or levers.



HYDRAULIC ACCUMULATOR.

The smaller of the two cylinders serves as the accumulator proper, the pressure in the same being obtained by that exerted on the ram of the larger cylinder, and which is either derived from a pump, or obtained by the employment of an independent accumulator which may be loaded with weights to a lower pressure.

In order to prevent the accumulator from running down too rapidly when communication is opened to a hydraulic pressing apparatus placed in connection with it, a valve is placed between the ram of the larger cylinder and the pipe communicating with the pump, or with the independent supplementary accumulator, so that when the ram of this cylinder is forced inwards by the action of the smaller ram, this valve is lifted, allowing a vent or free escape to the water contained within the larger cylinder; and when the pressure is reduced in the smaller cylinder, the valve closes, and the water is allowed access into the cylinder of the larger ram through a small orifice in the valve; or an orifice for the same purpose may be formed between the valve and its seat, or in the cylinder itself.

The differential accumulator may also be utilized as a cushion to prevent shocks, and to adjust or steady the pressure on hydraulic cylinders or pumps used in conjunction with it.

For the purpose of revolving the die boxes or dies in connection with an ordinary press, Messrs. Best and Marshall have designed the following arrangement: In front of the press is placed an upright shaft, on which is fixed the tables carrying the die boxes or dies, so that on the table being caused to revolve, the die boxes or dies pass between the ram and the press head. To the upright shaft is also fixed a bevel wheel, or a spur wheel, into which a pinion is geared, so proportioned that a certain number of revolutions of the pinion will cause the table to traverse an angle equal to the distance between two of the die boxes or dies. The pinion is caused to revolve by means of a sector fastened or cast to another wheel driven either direct or by means of intermediate gearing. On this wheel is fixed a pin, eccentric, or cam, to work the valves, and allow of admission into or discharge from the cylinder of the water employed in the working of the apparatus. The above mechanism is disposed underneath the revolving table, so as to be out of the way of the other parts of the machine.

Fig. 1 is a front elevation, and Fig. 2 a side elevation of the differential accumulator.

Fig. 3 is a view of the press head and revolving table carrying with it the die boxes (which may be of any convenient pattern). And

Fig. 4 is a sectional view, showing the apparatus on an enlarged scale.—*Universal Engineer.*

THE ITALIAN HUNDRED-TON GUN.

ON March 6th, 1880, one of the four 100 ton muzzle-loading Armstrong guns, which constitute the formidable armament of the Italian iron-clad Duilio, burst in the course of some experiments with these monster weapons. Two officers and seven men were wounded, but nobody was killed, while little damage was done to the turret in which it was housed. Twenty-eight rounds had previously been fired from the gun, and with heavier charges than those for which it had been designed. "The steel tube of the gun," writes a correspondent, who has kindly furnished us with the photograph from which our illustration is engraved, and which represents it before its departure for Italy, at Sir W. Armstrong's works at Elswick, "parted transversely, and drew out from beneath the coils, thus dividing the gun into two parts without any dispersion of fragments. The charge used on the occasion was 551 lb. of powder, with a shot of 2,000 lb. It is probable that an abnormal pressure, known to artillerists as wave action, had been set up owing to some irregularity in the cartridge and the mode of igniting. This action is known to be very liable to occur where the charge is very large, and where it is ignited, as in the present instance, from a rear vent without a free passage through the center of the cartridge. A little temerity appears to have been exhibited in advancing to these enormous charges without a certainty of avoiding the danger of this wave action."—*The Graphic.*

AUSTRIAN PASSENGER ENGINE.

WE are indebted to our excellent contemporary, the *Organ für die Fortschritte des Eisenbahnwesens*, for the drawings from which our engravings have been copied.

The engines were designed last year to work heavy passenger traffic at comparatively high speeds of from thirty-seven to forty miles per hour over a line abounding in steep inclines. To this end it was necessary to have a large boiler and plenty of adhesion. Although there were no curves to be traversed with a less radius than about 18 chains, it was deemed advisable to use a bogie, and Kamper's bogie having been tested since 1876 on the Rudolf railway, was selected. The engine is united to the tender by Herr Tilp's patent coupling, which prevents oscillation, and gives steadiness even at sixty miles an hour.

The construction of the bogie is perhaps the most noteworthy feature about these engines. It may be regarded as a four-wheeled Bissel truck, but in the details it differs materially from the Bissel arrangement. The bogie is pivoted behind, the pin being spherical, as shown in the longitudinal section. The block holding the pin can slide in a suitable slot. The Bissel bogie is pushed by the engine, but the Kamper bogie is pulled from the front by suitable draw links fixed to the leading buffer beam as shown. The engine is suspended from the bogie by slings, two at each side midway between the wheels, as shown in the longitudinal section and cross sections, and these stays are supplemented by helical springs, as shown in the detail view of a sling. In case a sling should break, incline planes are provided, as shown, which would then carry the engine. It is stated that the action of the Kamper bogie is very perfect, and we see no reason to doubt the statement.

To protect the lower part of the boiler shell from internal corrosion, a very curious device is employed. The whole bottom of the barrel is lined with copper plates, 1 millimeter—0·039 in.—thick, on a system patented by Herr Feldbacher, which has proved very successful. Hardy's vacuum brake is fitted to the tender only. The frames are of the mildest Bessemer steel; the reversing gear is a combination of the lever and the screw—Essig-Carmine's patent.

The engine, although very heavy, is, taken as a whole, an excellent example of continental practice. The principal dimensions are as follows:

General Dimensions.

Height over all	15 ft. 0 in.
Breadth "	9 ft. 11 in.
Length "	29 ft. 1 in.
Wheel base of bogie	5 ft. 7 in.
From rear bogie axle to driving axle	5 ft. 7 in.
Wheel base of coupled wheels	8 ft. 2½ in.
Weight of engine empty	39 tons.
" in working order	43·5 "
" on first bogie wheels	8·7 "
" on second bogie wheels	8·8 "
" on driving wheels	13·5 "
" on coupled wheel	12·5 "
Adhesive weight	26·0 "

Boiler.

Fire-grate: Length	6 ft. 3 in.
Breadth	3 ft. 7½ in.
Angle of inclination	20 deg.
Fire-box: Length over all, above	5 ft. 11¼ in.
" " below	6 ft. 2 in.
Breadth " above	3 ft. 6½ in.
" " below	3 ft. 7½ in.
Height " front	5 ft. 0 in.
" " back	3 ft. 8 in.
Thickness: Tube plate	0 ft. 1·024 in.
Sides	0 ft. 0·63 in.
Crown	0 ft. 0·787
Length of barrel	13 ft. 3½ in.
Mean diameter	4 ft. 4 in.
Thickness of plate	0 ft. 0·551 in.
Number of tubes, iron	180
Outside diameter of tubes	0 ft. 2 in.
Boiler pressure	150 lb. per sq. in.
Length of tubes between tube plates	13 ft. 1½ in.
Number of safety valves, Klotz's patent	2
Mean diameter of safety valves	0 ft. 4·37 in
Heating surface	1,357 sq. ft.
Feed apparatus, 2 injectors, Friedmann's patent	Nos. 7 and 9.
Chimney, Prüssmann's, smallest diameter	1 ft. 2·73 in.
Blast pipe, greatest area	24 sq. in.
" least "	8·4 sq. in.

Engine Frames.

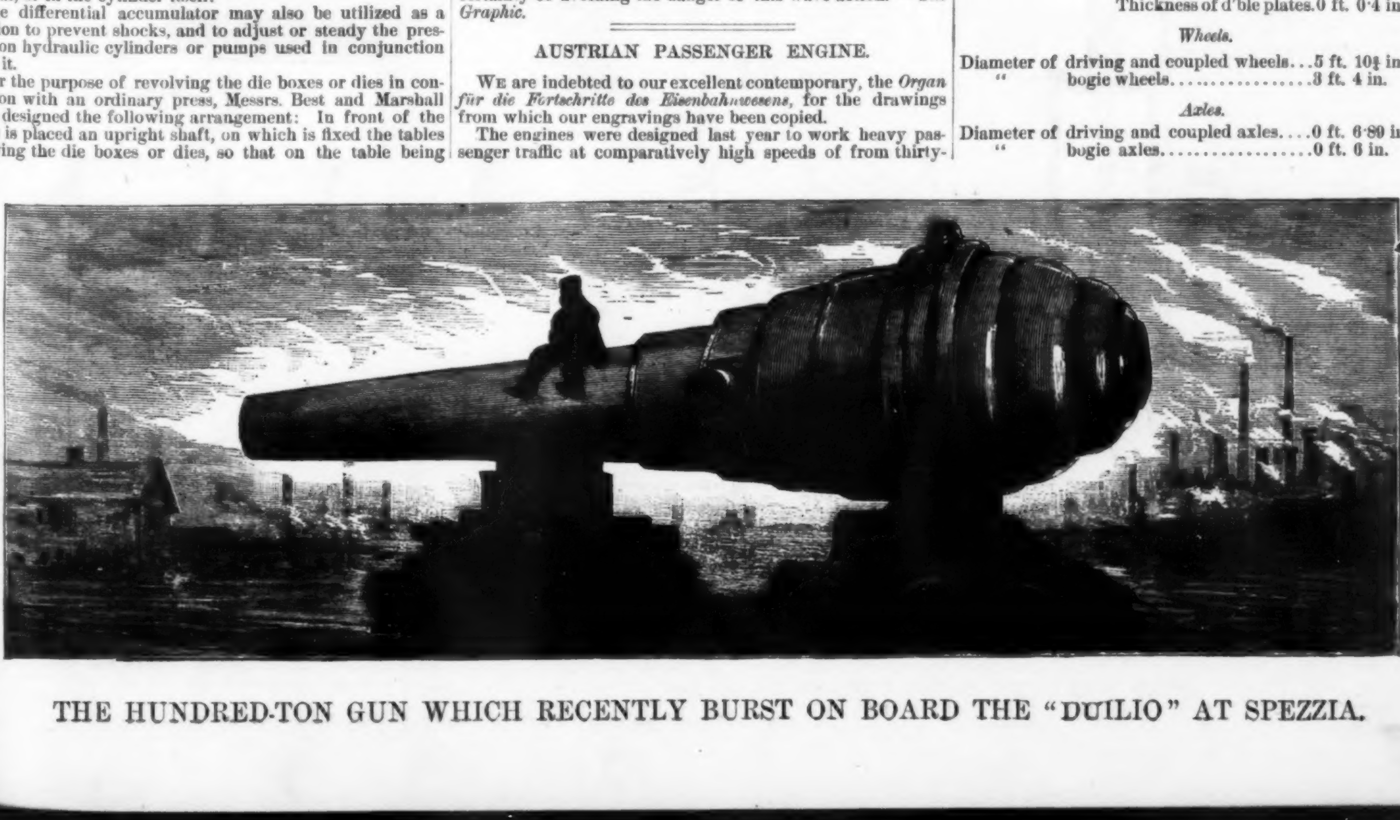
Principal frames: Length	26 ft. 7 in.
Depth	2 ft. 7 in.
Thickness	0 ft. 1·37 in.
Bogie frames: Length	9 ft. 4 in.
Depth	2 ft. 3 in.
Thickness of d'ble plates	0 ft. 0·4 in.

Wheels.

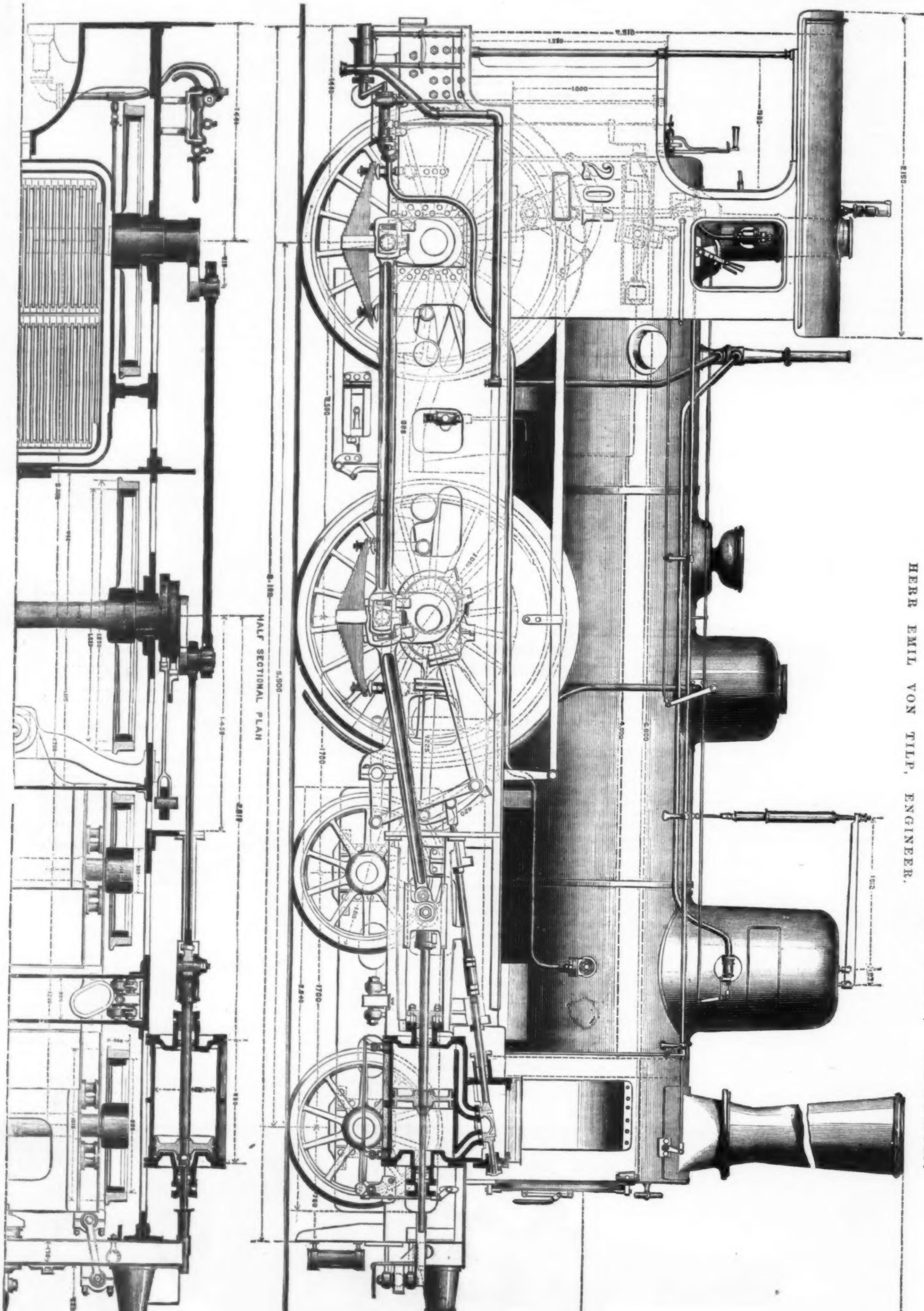
Diameter of driving and coupled wheels	5 ft. 10¾ in.
" bogie wheels	3 ft. 4 in.

Axles.

Diameter of driving and coupled axles	0 ft. 6·89 in.
" bogie axles	0 ft. 6 in.

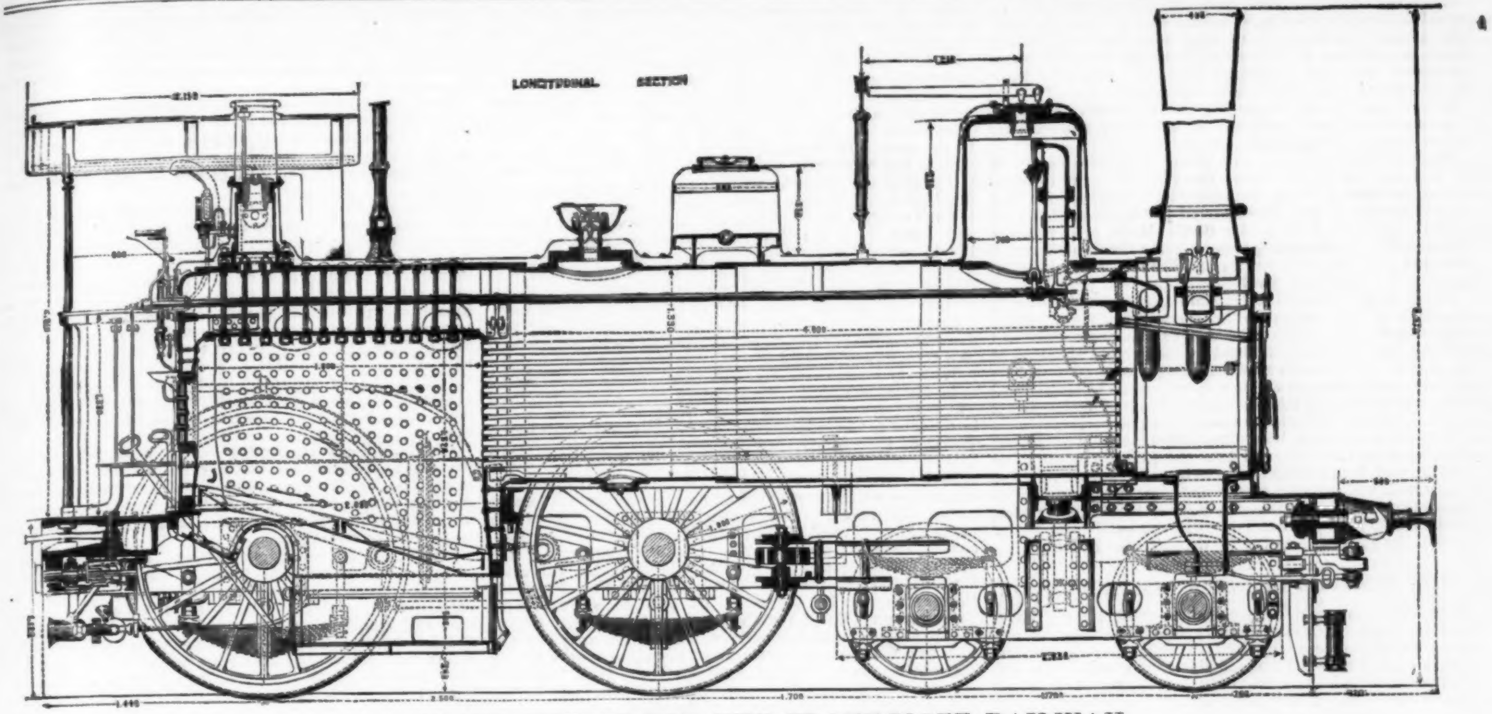


THE HUNDRED-TON GUN WHICH RECENTLY BURST ON BOARD THE "DUILIO" AT SPEZZIA.



PASSENGER ENGINE, KAISER-FRANZ-JOSEF RAILWAY, AUSTRIA.

HERR EMIL VON TILP, ENGINEER.



PASSENGER ENGINE FOR THE FRANZ-JOSEF RAILWAY.

Springs.

Distance between points of suspension of springs of driving and coupled wheels,	3 ft. 1½ in.
Number of leaves	17
Breadth "	0 ft. 3½ in.
Thickness "	0 ft. 0·34 in.
Distance between points of suspension of bogie wheel springs	2 ft. 7½ in.
Number of leaves	11
Breadth "	0 ft. 3½ in
Thickness "	0 ft. 0·34 in.

Cylinders.

Diameter of cylinders	1 ft. 4¾ in.
Stroke	2 ft. 0¾ in.
Length of connecting rod	6 ft. 6¾ in.
Distance of cylinders from center to center,	7 ft. 11½ in.
Throw of eccentrics	0 ft. 6 in.
Length of eccentric rod	4 ft. 1 in.
" slot in link	1 ft. 4½ in.
Outside lap of slide valve	0 ft. 1 in.
Inside " "	0 ft. 0·079 in.
Steam ports	1·37 in. × 11 in.
Exhaust port	3 in. × 11 in.
Lead of eccentric	15½ deg.
Length of valve	0 ft. 9·64 in.
Breadth "	1 ft. 1·78 in.

—*The Engineer.*

CAPS FROM STE. CHAPELLE, PARIS.

THE illustration forms another of the Royal Architectural Museum Sketching Club series, and is by Mr. T. Fredk. Pennington. The designs illustrated of capitals in the well-known chapel attached to the Palace of Justice, Paris, "a perfect gem of French thirteenth-century architecture," as it has been termed, are among the most interesting in the museum collection.—*Building News.*

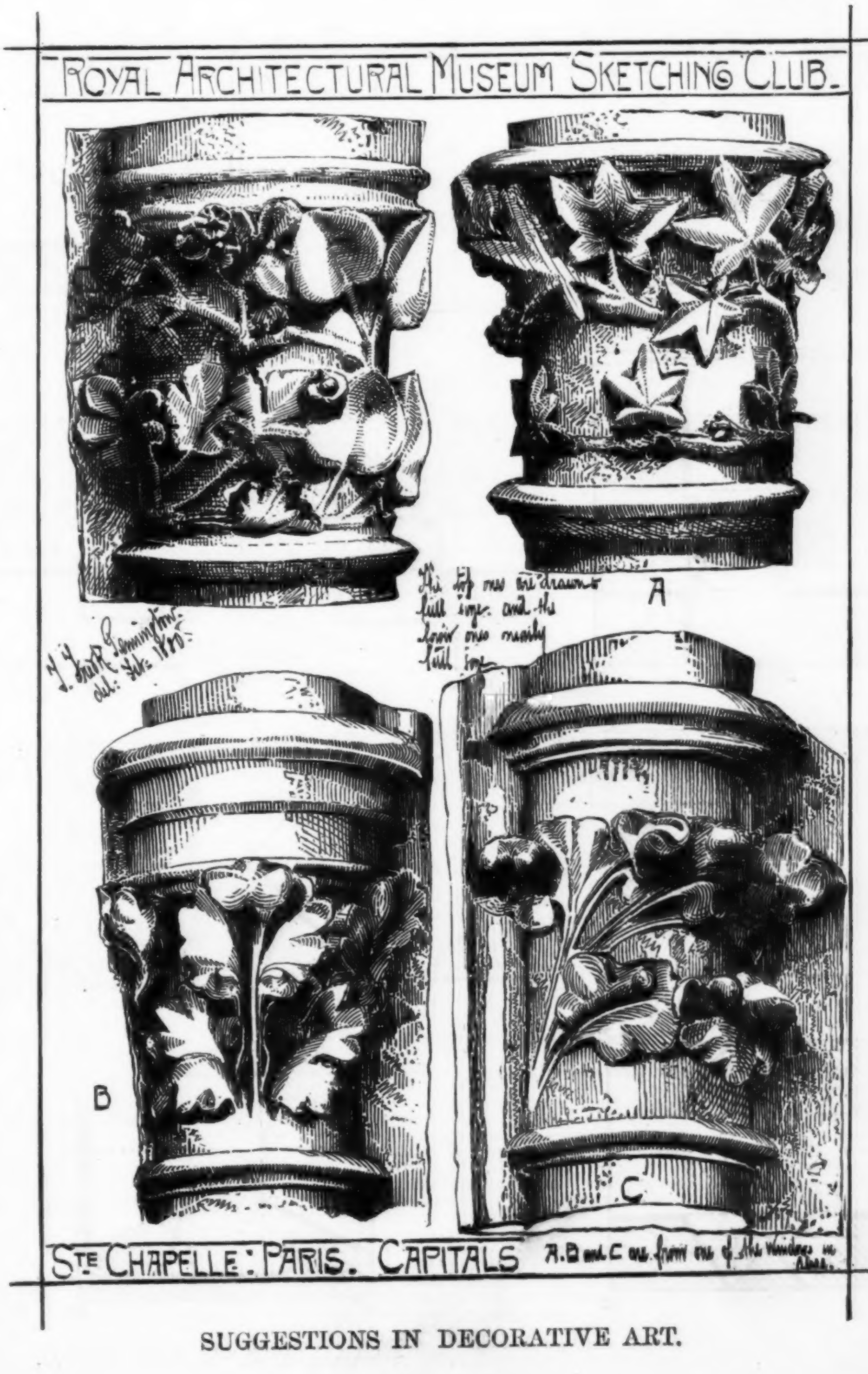
A RUSSIAN CRUISER.

THE construction on the Clyde, at Messrs. John Elder & Co.'s yard, of a Popoff yacht for the Czar, which is at the same time a powerful fighting ship for shallow waters, is not the only sign of the activity of Russia in strengthening herself at sea. The Russian volunteer fleet, the patriotic organization which procures ships with funds derived from public subscription, and has them manned and officered by the imperial navy, is having a fast cruiser built for it near Toulon, under the supervision of the Imperial Government. The Compagnie Nouvelle des Forges et Chantiers de la Méditerranée now possesses the shipbuilding yard at La Seyne, at which 6,000 or 7,000 men have been employed, at one time, in turning out vessels of war for Spain, Russia, and other foreign countries.

La Seyne is in a bay sheltered by the green headlands which inclose the roadstead of Toulon, and is half an hour's sail from the quay of Toulon town. At present the yards are comparatively slack, but one of the two large vessels building on the sequestered beach opposite the first naval arsenal of France is the new Russian cruiser—a fast and strong boat of steel and iron, armed with a beak, destined to carry tea and other high-freighted merchandise in time of peace, and in war to have her station wherever the merchantmen of the hostile power congregate. The name of the as yet unfinished cruiser is the Jaroslaw.

The Russian volunteer fleet has four other vessels, named like this, after the place which has contributed the funds required to build or buy them. These are the Moscow, the Nijni Novgorod, the Russia, and, lastly, the St. Petersburg (formerly the Thuringia of the Hamburg-American Company), which is lying here now under repair immediately opposite the slip on which the Jaroslaw is being built. The Jaroslaw is sufficiently advanced to enable the visitor to form an idea of her size and general design.

She is about 310 feet long, and her greatest width is 12·5 meters. Her depth is 8·2 meters, and her draught 6 meters. Her displacement is 3,150 tons. She is built with fine lines, and has an overhanging stern. She is strengthened with a double bottom, and her plates are two-thirds of an inch thick. It is stated that she has eight bulkheads, but I was not able to check this number by observation. The engines are not yet in her. She will not, indeed, be launched for some months.



SUGGESTIONS IN DECORATIVE ART.

When the engines arrive from Marseilles, they are expected to indicate 3 000 horse-power, and to give the Jaroslaw a speed of from 15 to 15½ knots an hour, which would be sufficient, if maintained, to enable her to overhaul our fastest mail boats, although the most recent of these have exceeded that rate on their trial trips.

Her armament will weigh 150 tons, and will consist of four cannon and two mortars. M. Lagarne is the engineer by whom she has been built.

There are no very noticeable novelties in the design of the Jaroslaw; she is not, from the point of view of naval science, so remarkable as the Admiral Duperré—a great turret ship for the French Government just launched from the La Seyne yard, or even as the Stella Maris, a ship fitted with elaborate refrigerating apparatus for the trade in fresh meat and fish between America and France, which is building close by in the same yard.

It is as an instance of the determination of Russia to be in a position to cause annoyance to a maritime foe that she is worthy of observation, and the danger she exemplifies will probably best be met in England by the general adoption of the plan for strengthening and arming our mail steamers and merchant steamers which was originated by Mr. Ward Hunt, and so warmly taken up by Mr. W. H. Smith. Great interest is felt in the scheme abroad, and there is considerable curiosity to know how many ships have been placed upon the Admiralty list, and how the shipowners are to be compensated for their alterations in construction. In the meantime it will not be uninteresting to have learnt what preparations Russia is making in the Western Mediterranean, building under the guns of Toulon as she builds also under those of the guardship on the Clyde.—*London Times.*

A NEW FEATURE IN INDUSTRIAL EDUCATION.

CONTINUED progress in processes of manufacture, refinement of machinery, and the new fields of discovery and advance which increased civilization and progress present, cause a rapidly growing demand for skilled labor. On the other hand, the minute subdivision of labor usually prevents apprentices in shops from acquainting themselves as they formerly could with all the details of the methods of work and processes of manufacture, and still less frequently have they the opportunity of learning how the work of the hand is but the outgrowth and accompaniment of the work of the brain. It is by the combination of the two, the hand and the brain, that skilled labor is produced; and the plan of the Russian system of workshops, first introduced in Moscow in 1868, is well designed to meet the necessity of a proper system of industrial education. In this system, now becoming well known to America by its introduction in the Massachusetts schools, notably the Massachusetts Institute of Technology, the hand is taught by the brain and the brain by the hand. Its object is not to secure great mechanical skill in any particular trade, but to give a correct understanding of the principles underlying all mechanical arts and manipulations; these principles are partially taught by and applied to practice, and a limited experience insures a useful and satisfactory practical result when accompanied by a liberal education in the branches of natural and applied sciences and in history and general culture. This system of education is still in its infancy, and though considerable success has already been achieved, upon its rapid introduction and future development and elaboration our progress in machinery and manufactures and social welfare will to a great extent depend.

With the system in its present form pupils are expected to be about the age of fourteen when beginning instruction. The new feature which we here present is one about to be introduced in the "Industrial School of the United Relief Works of the Society for Ethical Culture," of New York City, where children of ages ranging from six to eight are to receive instruction in the rudimentary principles of mechanical operations. It is well before describing this new feature to state that this school is a charitable organization which takes its pupils from the free kindergarten of the same society. These children are those of poor workingmen. It is under the management of a committee of which Professor De Volsen Wood, Professor Channing Whitaker, Professor Felix Adler, and Mr. Alfred R. Wolff, M.E., are members. The correct application of the system of industrial education to children of the age of six, while necessarily adapted to produce excellent results, a young mind and a young hand being easily influenced to adopt the right, presents peculiar difficulties. These seem to have been met in the plan adopted by the committee of the school and elaborated by Dr. G. Bamberger, its principal. Instead of working in wood, which would be beyond their strength, the children are to use their chisels upon a clay which is not brittle, gritty, nor soft, but cuts similar to wood. The following exercises shown by the annexed diagrams represent those designed as studies for the first year. An explanation of the tasks they present and the results achieved as the progressing difficulties are successfully overcome, will be of interest to our readers.

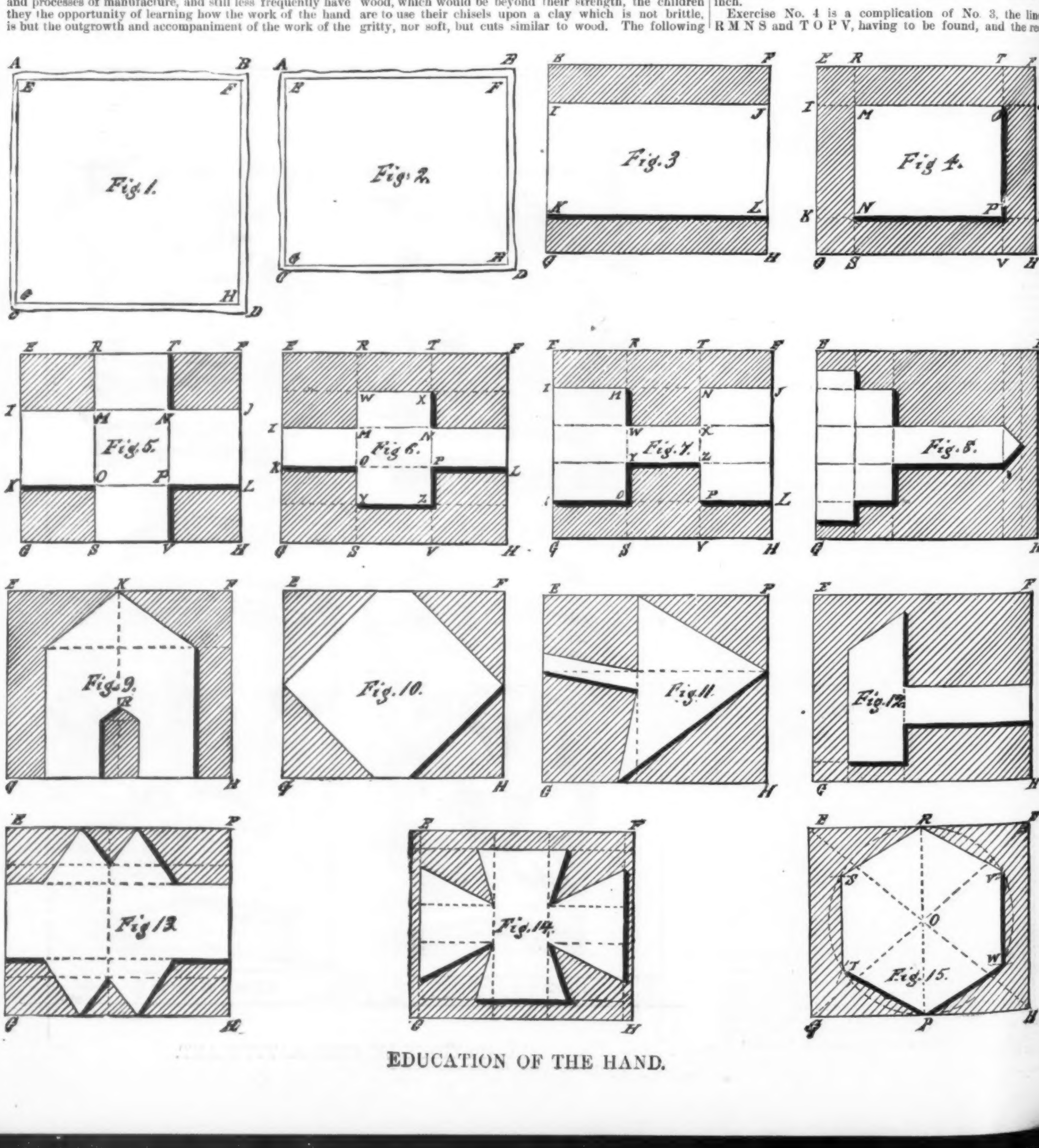
In all exercises pieces of clay of approximately the outline square or rectangle, as shown by A B C D in Figs. 1 and 2, about three-eighths to half an inch thick, are given to the pupils; these pieces, as will be observed, are not squared up at the edges, nor are the sides exactly at right angles to each other.

In exercise No. 1 (Fig. 1), the pupil is taught to draw the line E F, equal to six inches; he measures this with a rule furnished him, and then by use of a square draws the line E G, at right angle to E F, equal to six inches. G H and H F are then drawn and measured off in a similar manner, and the square, E F G H, is produced. All the properties of the square are called to the pupil's attention, how one side determines all the others, how the points, G and H, are equidistant from E and F, or in other words, how G H is parallel to E F, and F H to E G. A chisel is now presented to the pupil, and he is taught by following the sides of the square to cut out E F G H three-eighths to half an inch thick, from the piece of clay, A B C D, of the same thickness.

In Fig. 2 the rectangle, E F G H, is constructed by measurement in the same manner, and cut out with the chisel as in exercise No. 1. Rectangles of different sizes and proportions are constructed, and cause the child to gain experience in the use of the chisel, and make it familiar with the properties of the rectangle.

In Fig. 3, as in succeeding exercises, E F G H is scribed on the clay as in exercises 1 and 2, but no portion of the original form of the clay is cut until the entire design is outlined upon its surface. The points, I K J and L, are determined by measurement and construction, and the rectangles, E F I J and K L G H, are cut out one-sixteenth inch to one-eighth inch deep. The clay cuts similar to wood, and the pupil is taught to use the chisel the same as if he were working in the latter material. In this, as in succeeding figures, those portions of the diagram in section represent the parts as cut away to a depth of one-sixteenth inch to one-eighth inch.

Exercise No. 4 is a complication of No. 3, the lines, R M N S and T O P V, having to be found, and the rect-



EDUCATION OF THE HAND.

angles, I M K N and O J P L, having to be cut out in addition to those already removed in Fig. 3.

The increasing difficulty presented in exercise No. 5 is the introduction of the internal corners as represented by M N O P, which necessitates more careful manipulation of the chisel to prevent the breaking of the corners of the rectangle at E F G H, or mutilating the design.

Exercise No. 6 combines the difficulties of Nos. 4 and 5, and No. 7 is the reverse of No. 6, the part being cut away in No. 6 being retained in No. 7; thus, when the side, E F, is made to coincide with G H of No. 6, a design of outline, I W X J L Z Y K, of No. 7 is produced.

In exercise No. 8 oblique angles and lines are introduced for the first time. The method of laying out the figure is indicated by the dotted lines.

In exercise No. 9 several oblique angles and lines are presented; the construction is more difficult, the points, K and R, requiring especial care, and a design resembling a dog-hut or a house is produced to the satisfaction of the young mechanic.

Design No. 10 presents a number of corners and calls for a variety of cuts, most of them oblique to the design and the sides of the rectangle.

In exercise No. 11 there is quite a combination of oblique angles and lines, and the outlining of the design itself is fairly difficult. When the figure is cut and completed, the basis of a leaf is produced same as is used in wood carving.

Design No. 12, a hammer; No. 13, a form of screw; and No. 14, an "Iron Cross," present increased difficulties in laying out and in chiseling. The last exercise shown, No. 14, is a very important one and forms the basis of many others. After the rectangle, E F G H, is drawn, the corners, E H and F G, are connected (or the diagonals drawn) and the point, O, is determined. The pupil is taught how the point, O, is equidistant from the corners and also from the sides of the rectangle, and is thus made familiar with the idea of the center. A line is now drawn through the center, O, perpendicular to the sides, E F and G H, or parallel to E G and F H, and the center line of the figure, as such, constructed for the first time. A pair of compasses is now given to the pupil, and with the center, O, and the line, O P, as radius, a circle is drawn, and the hexagon constructed by laying off the radius upon the circle in the usual manner as shown in the figure. The shaded portion is then cut away with the chisel to a depth of one-sixteenth inch to one-eighth inch as before, and the hexagon stands forth in bold relief. The triangle, pentagon, heptagon, and other geometrical figures are then produced in a similar manner.

With the completion of the above exercises, the results that will have been achieved in the line of industrial education may be briefly summed up as follows:

1st. The pupil will have learned how to construct the principal geometrical figures, and will have become familiar with their properties and peculiarities, which it now often takes a much longer time to teach by more complicated and tedious methods.

2d. He will have become generally familiar with the method, necessity, and accuracy of measurement and construction.

3d. He will have acquired the correct use of the chisel with enough ease and accuracy to cut clay to the line, and to cut out an approximately plane surface.

4th. The acquisition of the points above enumerated will have prepared him sufficiently to work to advantage in wood, the same methods underlying workmanship in wood as in the hard clay used, and he will be enabled to make a much more rapid and intelligent advance in the more intricate problems the harder materials present than he otherwise could have done.

We will watch the practical working and results of this new feature in industrial education, the application of the system to children of the age from six to eight, and the accurate and intelligent workmanship in clay with much interest, and trust that we will be called upon to report its success.

THE NEW DIVING SYSTEM.

WE recently briefly referred to the remarkable invention of Mr. H. A. Fleuss, by which a diver is enabled to remain under water for several hours without any air supply from above. Although those who are conversant with chemistry may have gained a correct notion of how Mr. Fleuss accomplishes this apparent impossibility, most of our readers in common with the general public have doubtless been much puzzled as to the means employed. We are now in a position to describe the nature of the invention in detail.

The ordinary diving system hitherto in use has, thanks to the time-honored tank at the Polytechnic Institution, become tolerably familiar to both Londoners and visitors from the country. But it may be as well, before dwelling upon the important modifications introduced by Mr. Fleuss, to briefly consider the conditions under which an ordinary diver sinks below the water.

The diver's dress is a kind of over-all garment made in one piece. It is composed principally of India-rubber faced with tanned twill, and is fastened round the waist with a broad belt, in which is placed a hatchet or any other tools which may be required. The collar of the dress is made of thick rubber, and is secured to a metal yoke-piece, which, by means of strong screws, fits upon the shoulders. Upon this yoke-piece is screwed the helmet, at the back of which the pipe protrudes which furnishes the diver with his supply of air. In addition to this connecting link with the upper world, the diver is provided with a communicating cord, by which signals can be exchanged by means of a prearranged code. Each diver requires three attendants, two of whom are stationed at the air-pump, the sole duty of the other man being to hold the signal cord. It will be seen, therefore, that the paraphernalia required by the ordinary diver before he can become amphibious is by no means of a simple or inexpensive character. For in addition to the original cost of the dress and apparatus, which amounts to about £120, there is also to be taken into consideration the wages of four men.

Although this system has now been in constant use for many years, and has been gradually improved, it is by no means free from imperfections. In the first place the diver's sphere of action is very limited. The air pipe upon which his life depends must be a constant source of anxiety to him, besides which it utterly prevents him creeping under wreckage, and finding his way into places where his services might be most useful. In the next place the pressure of the air which is forced into his helmet must obviously always exceed the pressure of the water in which he is working, and this pressure, of course, increases with every foot of depth. At 40 feet it amounts to 17 lb. on the square inch; at 100 feet it reaches 43 lb.; and at 150 feet, 65 lb. This constant strain upon the respiratory organs is the most trying difficulty with which the diver has to deal, and it is not an uncommon occurrence for a man when working at a great depth to bleed from the nose, ears, and eyes.

Such briefly was the system commonly in vogue for the prosecution of subaqueous work, a system which will probably be altogether superseded by the method of diving invented by Mr. Fleuss, now to be described.

Any manual of chemistry will give the information that the air which we breathe is composed of two gases, oxygen and nitrogen, in the proportion of one-fifth of the former to four-fifths of the latter. When this air has been exhaled from our lungs it has undergone several changes, two of which only are important to the subject in hand: 1, it has been robbed of some of its oxygen, and 2, it has become highly charged with deadly carbonic acid. The nitrogen, it is important to observe, is unaltered. Its particles enter the lungs and leave them, acting in a negative way as a kind of dilutant to the oxygen. The reason, then, that a man cannot go on breathing the same air over and over again with impunity, is that the oxygen becomes partly absorbed by the blood in every breath we take, that the carbonic acid exhaled is highly poisonous, and that the nitrogen—although unaltered—is insufficient of itself to support life. The task upon which Mr. Fleuss has employed several years of hard study, and in which he has so admirably succeeded, was then of a twofold character—first, to obtain a supply of oxygen for taking the place of that absorbed in the act of breathing; and, secondly, to render the carbonic acid incapable of mischief—the nitrogen he did not trouble himself about.

Fig. 1 shows a section of his helmet, outwardly no larger than an ordinary diver's headgear. It consists of two distinct chambers, one of which is placed inside the other.

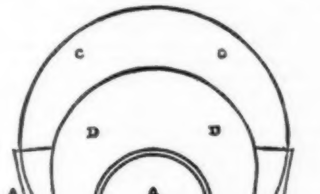


FIG. 1.

The space between them, C C, measuring only a quarter of a cubic foot capacity, is used for storing oxygen compressed to 240 lb. on the square inch. The interior space, D D, is occupied by the diver's head. A A A are windows, B is a valve under ready control of the hand by which the supply of oxygen from C C to D D can be regulated to the greatest nicety. This, then, is the way in which Mr. Fleuss overcomes one of the problems which he set himself to solve. The air in his lungs and about his somewhat capacious clothing when he first dons his costume contains the necessary nitrogen for indefinite use, for it is breathed again and again, and the oxygen absorbed by his blood is constantly replaced by the compressed gas stored above his head. There remains the other problem, the riddance of the poisonous carbonic acid.

To understand how this difficulty is overcome we must again consult our chemical manual. There we shall find that certain bodies have the property of absorbing or of entering into combination with carbonic acid. Thus caustic potash or caustic soda when treated with the gas will form with it carbonate of potash, or of soda, as the case may be. Mr. Fleuss tried, therefore, to find out some way of passing the air exhaled from his lungs through a solution of one of these caustic alkalies, so that its poisoned properties might be rendered innocuous. Fig. 2 will at once explain how he finally contrived to accomplish this end.

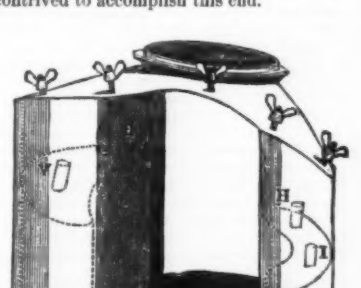


FIG. 2.

At the upper part of the cut is shown the yoke-piece upon which the helmet is screwed, and round its edge are seen the screws which are used to fasten the outer India-rubber garment in its place, and which cause the joint to be perfectly water-tight. To this metallic collar are fixed two curved shields, one in front of the diver and one at his back. The area inclosed by these shields is sufficiently great to include space for two vulcanite receptacles, E and F, for the reception of the caustic soda, the use of which has already been pointed out. The soda is in solution, and is held in the pores of spongy India-rubber, with which the two receptacles are filled. This being understood, we can now trace the passage of the air from the diver's lungs through the system of filters which these caustic holders represent. Over the mouth and nose is fitted an inhaler, not unlike that arrangement which is used by dentists for the administration of anæsthetics (Fig. 3). A valve on each side is so arranged that it opens during inspiration, but closely shuts as the air is exhaled. The breathed air has, therefore, no other course but through the flexible tube which proceeds from the inhaler. This tube is fastened to the nozzle, I (Fig. 2), on the front receptacle, E, containing the caustic soda. It proceeds by a pipe to the very bottom of the box or case, and then finds its way through the spongy rubber to the outlet, H. Here another pipe, not shown in the cut, conveys it over the shoulder to H I on the upper surface of the case, F. It follows precisely the same course as it did at E, finally escaping in a filtered and purified condition at the outlet pipe, V. From this point the filtered air finds its way to the inner helmet, where it receives its fresh complement of oxygen in place of that which it has lost in the diver's body, and is once more breathed into the lungs. The same operation is repeated as long as the diver remains below water. The chamber in the helmet, CC, holds exactly four feet of oxygen at the pressure already named. This quantity is found in practice to afford sufficient air food for five hours' consumption. It need hardly be said that this is more than enough for all practical purposes, but the quantity could easily be doubled if necessary. Oxygen so compressed that ten cubic feet will only occupy the space represented by an iron bottle, two feet long by five inches in diameter, is now sold in London and other towns as a marketable commodity. This convenient system of storing the gas is taken advantage of by Mr. Fleuss. A pipe between the bottle and the helmet will charge the latter in two minutes, or less, and the said bottle is so portable that,

FIG. 3.

in the case of a sudden demand for divers at any seaport in the kingdom, the gas could be sent down by train without the least difficulty. The same remark applies to its use on shipboard, where bottles of gas could be kept in store without risk of deterioration.

The advantages claimed for the new diving system are very many. In the mere question of expense, the absence of the air-pump, with its cumbrous adjuncts, reduces the first cost of the apparatus to about one-half. The working expenses show nearly as great a reduction, for only one attendant is required instead of the three formerly necessary. The cost of oxygen and caustic soda amounts to about sixpence per hour while the apparatus is at work. This saving of expense is one of the most important advantages of the system, and one which is sure to attract attention to it. Another still greater benefit secured by its use is that the diver, instead of being subjected to a distressing pressure upon head and lungs, is breathing air the pressure of which is normal.

Upon reference to Fig. 2 it will be seen that the diver is so shielded, behind and before, that, at whatever depth he is working, the water pressure can only affect his limbs. The air he breathes is supplied to him as naturally as it would be above water. It is hoped, therefore, that, by means of this new method of breathing under water, divers will be able to go safely to far greater depths than were ever before attempted, or, indeed, possible.

There are several other fields of labor in which the new system can doubtless be employed. In fiery mines the rescue of unfortunates struck down by the deadly after-damp would be a comparatively easy matter. A modification of the apparatus is also in contemplation for the use of firemen, by which they can enter the densest smoke without fear of suffocation. It is also suggested that aeronauts will, by incasing themselves in Mr. Fleuss' armor, be able to go far beyond the seven or eight miles to which they have, on account of the unbreathable air at those altitudes, been hitherto limited. Then the system can be applied to a new form of diving bell, which, like the dress itself, would be independent of pipe or air-pump. From this to submarine vessels is but a step, and we may perhaps soon hear of some practical contrivance for boating below water as easily as upon its surface. More than one submerged vessel has been designed, but has failed in practice. The last of these unfortunates was, if we remember rightly, named the Nautilus, and was designed by Mr. Scott Russell for operating against the Russian navy during the Crimean War.—*London Graphic.*

WHEAT HANDLING IN AMERICA.

THE relative advantages and disadvantages of English and American millers is a subject on which there is at present much discussion, and on which great diversity of opinion exists. *The Miller* has always contended that, with equally efficient machinery, the English miller is able to compete, on at least equal terms, with those of the world for the trade of the United Kingdom; but the latter does not always follow the reasoning and, in some instances, takes the pessimist view, that the practical extinction of the milling industry in this country is only a matter of time, owing to the manifold advantages of his (especially American) competitors. These advantages are supposed to lie not only in his position, in direct communication with the great wheat-growing district of the West, and his system of manufacture, or the perfection of his machinery and its utility for the various processes, but also in the production and handling (or manner of marketing) this crop, his command of cheap water power, and lower rates of freight. To estimate properly the value of these supposed advantages it is necessary to follow the grain from the field to the point of con-

sumption, giving a general idea of the tolls it pays in the form of profits to dealers, of charges for carriage, of commissions and shipping charges, either in the shape of wheat or flour.

First, to follow the wheat itself in its progress from the farm to the ports on this side the Atlantic. Of course the method of handling varies somewhat in different parts of the country, but the North-Western States at present enjoy the pre-eminence in all that concerns grain, and may be considered representative, so as to avoid confusion. Through these States, lying to the westward of the great lakes, run a number of railroads whose direction is, for the most part, east and west. As far as these railroads extend, and for some distance westward of them, lie the farms on which the wheat is raised. In the United States, with the exception of such territory as borders on the great lakes or navigable rivers, the railroad is the pioneer of cultivation. The latter precedes the former for a certain distance, but, unless there is communication from the railroad by water, cannot exceed that limit, and comes to a standstill when that limit is reached, until the railroad advances through the already settled country beyond its provisional terminus, and so enables the land, which is now brought within the necessary distance of steam communication, also to be settled up. Much of this land is settled under the Homestead and Preemption Acts—that is, government land—by which the settler obtains a clear title to 160 acres after five years' occupation and cultivation thereof. Another large part consists of grants to railroads passing through unsettled territory, which is sold by them to actual settlers at very low prices, so as to induce population along the line, the road thus making its own business. These settlers often know nothing about farming, and wheat being the article most easily raised and disposed of, devote almost their whole attention to its production. Indeed this is, to a great extent, true of most of the farmers of the Northwest, though in the more southern portion of the section and to the south of it, Indian corn becomes a formidable competitor. For their grain of all kinds these farmers must have an easily accessible market, and this is furnished them.

At every station on the railroads, or landing places on the navigable rivers, are located the wheat buyers, besides others who are at a distance from any means of steam communication; but these latter are few in number. Each wheat buyer has his elevator or warehouse, usually so situated that he can load directly either into the railroad cars or grain barges, without any cartage. The farmers bring in their wheat and sell it to the wheat buyer, by whom it is weighed and paid for in cash or goods. The latter is the case where the buyer also keeps a general store, in addition to his business in grain, which happens quite frequently. When the wheat is unloaded from the farmer's wagon it is graded by the buyer, that is, the latter forms his own judgment as to the quality, and shoots it down in bulk accordingly, putting together all that he considers No. 1 in one place, and all No. 2 in another. When he has accumulated a sufficient quantity of any one quality to ship, usually one or more car loads of about 10 tons each, he loads in bulk, and forwards it to his commission merchant at one of the large primary wheat markets, such as Milwaukee or Chicago.

The business of a commission merchant in these markets is one requiring large capital, inasmuch as he is compelled to advance on all shipments made to him, and if there happen to be a scarcity of empty railroad cars, also on grain, etc., in the warehouses of his customers, awaiting shipment. Thus he furnishes the capital necessary for the collection and purchase of a large part of the grain which he receives to sell on commission, and this explains the ability of the country buyer—generally a man of very limited capital, though not always so, some large firms being engaged in the business—to pay cash for the grain when it is brought to market by the farmers. The grain is shipped in bulk by the country buyer in ordinary merchandise cars, but fitted with what are called grain doors. About ten tons constitute a car-load, and it is frequently not weighed by the shipper, there being marks on the inside of the car which enable him to estimate tolerably closely what amount he has loaded. No weight is stated on the way bills accompanying these cars, the loads being simply taken as more or less (sometimes it is estimated at 20,000 lb.) at owner's risk, and the rate per 100 lb. is filled in. Each car-load is consigned to a commission merchant, and on arrival the number of the car, nature of the goods, and shipper's and consignee's name, are entered in a bulletin book at the station to which it is consigned. Previously to this the shipper has usually advised his commission merchant of the shipment, with directions as to its disposal. Each commission merchant has a man specially in attendance at the railroad yard, who ascertains from the bulletin what cars, consigned to his employer, have arrived, and his duty is then to hunt them up and see the grain inspected. The chief inspector is usually appointed by the local Chamber of Commerce or the State Government, and appoints his own sub-inspectors, and is paid either a regular salary, or, as in Milwaukee, at the rate of 10 cents (5d.) per car-load for inspection, this charge being added to the freight. The inspector's duties commence at seven A.M., when he begins by inspecting those car-loads of grain which have arrived during the night and which have been placed on a certain designated track or tracks contiguous to the elevator. Accompanied by an employé of the railroad company, who unlocks and opens the car doors, he examines each car-load of grain in turn, when necessary testing it further by means of the chondrometer, and decides what it shall be graded; and from his decision there is practically no appeal. Inspection is usually compulsory. The man sent by the commission merchant to watch inspection accompanies him and makes a note of the grade of each car-load to report at headquarters. In some cases he proceeds to carry into effect instructions previously received from the shipper, or to act upon his own discretion. For instance, he finds that a car has arrived from a certain shipper, consigned to his employer, which the consigner has advised as loaded with No. 1 wheat. The inspector refuses to grade it higher than No. 2. Now the wheat may not be *quite* good enough for No. 1 and yet *very* good No. 2. In such a case the commission merchant's man has it put into a special bin in the elevator, where it is kept separate from other wheat of the same grade, or else has the car put on a side track, in either case to allow of the wheat being sold by sample.

Attached to each of the railroad yards is one or more large elevators,* often capable of storing over 1,000,000 bushels of grain. A track runs through the building, underneath which are hoppers for the reception of the grain as it is shoveled out of the car. Each of these hoppers connects with an ordinary elevator, which again discharges into a hopper scale, capable of weighing a whole car-load at one draught. From the scale the wheat is run into the bins devoted to the storage of that particular grade; only the different grades being kept separate, while grain belonging to many different owners, if of the same grade, is run together. Loading into cars again is, of course, merely a reversal of the above, and as the elevators, wherever practicable, are also placed on the brink of water communication, the grain can be spouted from the elevator into vessels, in bulk, with the same ease.

Supposing the grain to have satisfactorily passed the ordeal of inspection, as many cars as the elevator is constructed to unload at once are switched in, the grain doors are lifted out, and two men, with steam shovels, to each car, empty all the contents into the hoppers under the track in the course of a few minutes. The grain is then elevated, weighed, and run into its appropriate bin, the weigher making a note of the number of each car, and the weight of its contents. These he transmits to the freight office, where the weight is filled in on the way-bill, the freight calculated, freight bills made out, and the sending station advised of weight and amount of freight. The freight is paid at once by the commission merchant, who then secures possession of the grain. He knows from his own man the grade, and thus ascertains what amount and quality of grain he has to sell.

The grain itself never actually comes into the commission merchant's hands; he receives from the elevator company only a receipt stating that they will deliver to him, on demand, so many bushels of wheat, barley, or other specified grain of such grade. These receipts are made out for any quantity required, usually, except in the case of car-loads put into special bin, in even thousands of bushels, or some multiple thereof. The receipts are deliverable against all contracts, being considered equivalent to delivery of the grain itself. Every day the commission merchant has credited to his account by the elevator company, in a little book like a banker's pass book, the amount of grain which has gone into the elevators for him; while on the other side he is debited with the receipts which have been issued to him, and which are always deliverable to bearer. Thus the elevators are in many respects like banks.—*London Miller.*

* Throughout the Western States the word elevator is used to describe a building used for the storage of grain, in which elevating machinery is employed.

WHEN DID MAN MAKE HIS APPEARANCE ON THE PACIFIC COAST?

THE following article, by the Hon. B. B. Redding (Reno *Gazette*), deals with a subject which cannot fail to interest all who look beyond their own lives to the life of the human race—all who long to pierce the veil that shrouds the origin of man.

In no part of the world is there so good an opportunity to gather facts as to the extent of time that man has been an inhabitant of the earth, as on the Pacific coast. Prospectors and miners are at work in all directions. Hydraulic miners are washing down hills; drift miners are delving at the bottom of extinct pliocene rivers; prospectors for gold, silver, and cinnabar are turning up the surface in all probable and improbable places, over an area of at least 16,000 square miles; and farmers plow up the burial places of prehistoric man, and enrich their gardens from the shell mounds and kitchen refuse of a people who had disappeared from the earth countless ages before Abraham and Lot divided Palestine into sheep ranges. All of these people find frequent evidences of the work of prehistoric man. Instead of being saved and placed in some public institution where they can be preserved, studied, and compared, they are either left where found, or adorn some bar-room collection of quartz, crystals, pyrites of iron and silver ores. There is no archæological society on the Pacific coast; even

"THE SOCIETY UPON THE STANISLAUS"

has become extinct. The total collections of the work of prehistoric man of the Pacific coast, in the California Academy of Sciences and in the State University, will number but a few dozen mortars, obsidian knives, scrapers, and arrow-heads, while the Smithsonian Institution, the French Ethnological Institute, Harvard University and the British Museum contain collections that may be measured by the ton. If miners and farmers on the Pacific coast who turn up mortars, spear-heads, or other works of man, made from stone, would send them to the Academy of Sciences, or to the University, with a short account of the place where and the circumstances under which they were found, the archæological student would not be compelled to visit the Smithsonian or Harvard collection to obtain the means of comparison between the works of the people found here by Father Junipero Serra, and the race that lived on this coast before Shasta, Lassen Butte, and other now extinct volcanoes capped the Sierra with sheets of lava, or with those of a still more ancient people, who hunted and fished among the foothills of the Sierra when these hills were washed by the waters of the Pacific ocean—probably long before the coast range of mountains made its appearance above the sea.

WHEN SHASTA AND OTHER VOLCANOES

were pouring out lava, filling up the ancient river channels, forming our hydraulic mines, and causing a new system of drainage for the Sierra, the volcanoes of the Cascades in south-eastern Oregon were sending out ashes, filling up the lakes, and making fossil the camel-llama, the one-toed horse, the saber-toothed tiger, and other animals that then roamed over that lake country. Vesuvius, in historic times, covered Pompeii and a region about five miles square with ashes. Southeastern Oregon is covered with volcanic ashes over an area of more than 200 square miles.

The evidence is beginning to accumulate that man lived in this then lake region of southeastern Oregon contemtemporaneous with the fossil horse, the camel-llama, and other animals now extinct. In Big Bone prairie, in the Silver Lake region, in connection with the remains of these animals, Prof. Cope's men lately found arrow-heads and so-called spear-heads. These differ in form from any now used by California or Oregon Indians. These so-called spear heads are flakes of obsidian of various lengths, from five to twelve inches, chipped into a long, oval form, pointed at both extremities, sharpened at the edges, and varying in thickness at the thickest part—dependent upon the length—the smallest being a half-inch, and the largest an inch. Whatever the size, the form and proportions are always relatively the same. They were probably not spear heads, as, if used for this purpose, there would be no object in sharpening both extremities. They were probably knives used for some special purpose. The oldest living California and Oregon Indians do not use them, and do not know what they were for. The McCloud Indians

STILL MAKE STONE KNIVES,

scrapers, arrow-heads, but nothing of this form. None of this kind have been found in the shell mounds or burial places of Pacific coast Indians, and some of the "kitchen middens" of the coast of California must have been thousands of years in accumulating. They have never been found in California, except below the bowlders in hydraulic mines, at the bottom of extinct pliocene rivers, or below the auriferous earth and gravel of placer mines, and, as stated lately by Prof. Cope in Oregon, in connection with the fossil bones of extinct animals. There are two of these spear heads in the Smithsonian collection, one from the hydraulic mines of Calaveras county, and the other, numbered 7,342, from Folsom, Sacramento county. This spear head was found, with a disk of slate, having a hole in the center, on a ledge of granite, at the bottom of the gold mines, twenty-three feet below the present surface of the streets of the town of Folsom. About thirty feet below the streets of Folsom the miners find a bed of hard, salt-water mud, filled with fossil oyster shells, and shells of the extinct crustaceans of what Clarence King calls the miocene ocean. This ledge of granite is a point from the foothills of the Sierra that jutted out into this ancient sea. Who were the people that hunted and fished along the foothills when the base of the Sierra was washed by the ocean? Was the top of Diablo then an island? Or was the

SACRAMENTO VALLEY AN ISLAND SEA

like Puget Sound or the Black Sea? It is not singular that more of the spear heads of these primeval people are not found, or that when discovered they should be found beneath the drift and bowlders of our gold mines. If any were left on or near the present surface, and had been discovered by the ancestors of our present Indians, they would have been split into knives and arrow-heads, for obsidian in any form was of the first necessity, and the most valuable material in use until white men brought iron to the coast. So far as I can learn, there are five of these peculiar spear heads in public institutions: two at the Smithsonian, two in the possession of Prof. Cope, and one at Harvard. There are probably dozens in miners' cabins, or ornamenting bar-rooms in the mountains, or used as paper weights in village grocery stores in California and Oregon, which, if they could be gathered in some public institution, with the facts and history of their discovery, would go far to prove that man made his appearance on earth, and lived on this coast, when the mastodon, elephant, cave bear, and saber-toothed tiger wandered among the foothills of the Sierra, or, perhaps earlier still, when the earth had so far evolved from hot chaos as to develop a climate that would give him food and provide him with shelter.

WINDOW GARDENING IN SMALL HOUSES.

By MRS. M. W. HUDSON.

THIS is not a dissertation on the Aphis, nor a treatise on the ingredients of the soil and the proper humidity of the atmosphere, but a protest against giving the sunniest, and perhaps the only southern window in the house, to plants all winter.

The poetical idea that plants in the house have a refining influence leads many women to keep "just a few," though her rooms are small and cold, fuel scarce and expensive, her windows few and her children sometimes many, and always dear.

Once having potted and brought her plants in, she actually forms an attachment for them or she would not tolerate the starved and half-frozen things before her eyes for months. A polite way of accounting for the fact that a woman who really appreciates flowers can cherish the sickly and straggling plants that obscure so many windows in winter would be to say that it is one of the mysteries of the feminine mind. It must be. Probably, also, it is the same mystery that blinds women to the fact that children in the background of a little window religiously curtained as to the upper half and devoted flower pots and a bird cage below, have complexions like the inmates of a lunatic asylum or a "shepherd's fold."

A dozen times a day they are told: "Don't go near the window, children, you will upset the plants." At night the pots must all be lifted to the warmest corner, very often at the expense of a grudging word from her liege lord, who does not, however, give any good reason why he thinks them nuisances, and is inclined, notwithstanding his complaints, to humor his wife in the matter of a few plants if they afford her any pleasure, and she declares they do. Occasionally, to be sure, window plants in small houses are so well taken care of that they thrive and bloom and gladden all the household, but any housekeeper must know that they are nearly always matured by the exclusion of fresh air and the sacrifice of sunshine.

In small houses the ventilation for night, as well as day, must frequently be secured through the living room, and if plants have to be saved from freezing by keeping every crack in the windows closed the sleepers must suffer. The common belief that plants in a sleeping room are injurious to health is unauthenticated in practical experience, except for this reason. The deleterious gases a few plants will exhale in a night have an insignificant effect on the human system compared with the influence of repeatedly breathed air, but the cheering effect of a few unseasonable flowers will not compensate for the lack of sunshine in the house.

Baby's playhouse should be just under the window where the flower stand is; it will do him quite as much good to flatten his little nose against the glass and revel in the sunshine as it will do the bursting buds to drink it all day long. And when baby's mother sits down to sew and read, it will do her more good than all other tonics can to sit in the full glow of the vivifying sunlight.

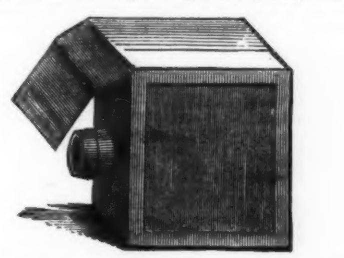
Shaded rooms depress the spirits and benumb the mind as well as the body. It is a sanitary wrong that no intelligent wife and mother will be guilty of, to darken the windows and keep her family in perpetual gloom. The sunniest rooms in the house should be the living rooms, and the people in the house should have the benefit of the first seats before the shrine of light; not even heliotropes and roses should intervene. Homes that have enough windows to supply both the human inmates and plants with light and air are, of course, not referred to here, and the woman who has time and space for the cultivation of flowers would not be of the nature that men love if she did not have them the year round; but since such a large proportion of Western people live in small houses, few of them are sufficiently well lighted, and since window gardening in winter is becoming more general each year, because it is so constantly urged by seedsmen and florists as one of the things women should do, it seems time that some one entered a plea for the baby's rights.—*Kansas City Review.*

WILLIAM ENGLAND, PHOTOGRAPHER.

MR. WILLIAM ENGLAND is probably the largest continental publisher of European views, and here at St. James's Square, or rather in a compact little establishment at the back of his residence, is the source of all the prints issued in his name. In the summer, Mr. England travels in Switzerland, the Tyrol, and Italy for months together with camera and apparatus, bringing back with him additions to his series of photographs, the names of which fill a good sized pamphlet. Mr. England confines himself for the most part to views of small size, or, in other words, rarely goes beyond a 10 by 8 plate. His favorite traveling camera is standing in a corner, and he sets it up for our inspection; it will do for stereoscopic pictures, or for whole-plate negatives. "Here is a simple arrangement for shading the lens," says Mr. England, and he shows us what appears to be the peak of a cap made of mahogany. We made a rough sketch of this apparatus, and here it is. The front flap measures four inches and the middle flap about three, and the double hinge arrangement permits you to bend down the peak right in front of the lens, if you like, so that you may almost employ it as a cap. But for shading the lens the arrangement is invaluable, and traveling photographers would be wise indeed to adopt so simple a modification to their apparatus. The harmony and delicacy of Mr. England's landscapes are proverbial; the sun's glare is never permitted to exercise a baneful influence upon the middle distance and horizon, and this simple shade has much to do with Mr. England's reputation as one of the first landscape photographers.

"And this is my traveling stand," says Mr. England. "I have knocked about with it all over the Continent for eleven years, and it is as sound now as on the day it was made." It certainly is a model tripod, with two very valuable properties: it has a broad base-board, whereon to screw the camera, and it is exceedingly light. Indeed, it is wondrous strange that the material of which it is made is not more generally employed for camera stands; its whole virtue is summed up in the word bamboo. For strength and lightness the stand is simply unrivaled, and when we say that the bamboo receives a good character from a man of experience like Mr. England, there can surely be no better recommendation.

Mr. England is a man of resource. At St. James's Square he prepares his own plates, makes his own varnish, albumenizes his paper, prints and mounts his pictures, and does what lithographic or letter-press work the mounts require. Here is a model little printing establishment with two type-presses and a litho-press; and adjoining is the compositor's room, with type trays and desks complete. Both litho-press and printing-press are busily at work just now, and stacks of white and yellow mounts are standing by ready for printing. Farther on, across a spacious yard, half covered in with glass, where the printing takes place, is another



building devoted downstairs to the toning and washing of prints, and upstairs to albumenizing paper and sensitizing it. The albumenizing is done when eggs are cheap, and there is very little mystery about the matter. The best Saxe paper is employed, and this is floated upon the albumen in the same way as paper is sensitized. White of egg to the extent of a few gallons is worked vigorously by a revolving whisk, and the salting solution added at the same time. The latter is in the proportion of:

Chloride of barium	5 grains,
Chloride of ammonium	5 "
Albumen	1 ounce,

the chloride being first dissolved in a little water. The albumen, after whisking, is permitted to stand three days, and after being filtered through flannel is ready for use. Mr. England does not have recourse to hot plate pressing, or any other similar process.

The sensitizing takes place on a fifty-grain bath, a three-minute glass, or egg boiler, being methodically used to control the time. Mr. England prefers to dry his paper by artificial warmth, rather than spontaneously, and employs for the purpose a cupboard heated by a water bath; the water bath, while it causes the paper to dry quickly, does not permit it to become horny. The water bath supplies a damper heat than the outside air. The paper shows no creases, and exhibits no tendency to blister.

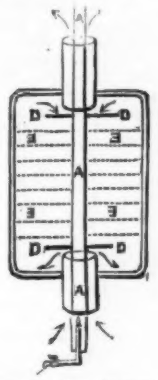
Mr. England's washing apparatus has already been described in these columns, but we may refer to it once more. In a big oblong trough is a big oblong tray; the bottom of the tray is composed of trellis work made up of gutta-percha strips, and into this tray the prints are put. The trough contains water, and this naturally rises into the tray. The tray rests a few inches from the bottom of the trough, being pivoted in the middle at each end, so that it rocks on the slightest provocation. A little water wheel at one side furnishes this provocation. A tap of water is running, and gradually fills up the buckets of the water wheel, and whenever they are full, the water wheel makes one revolution; in doing this, it lifts an arm attached to one side of the rocking tray, and the tray is thus lifted bodily on one side, causing the prints therein to be considerably agitated. Thus the prints lying in the water are vigorously shaken up every time the wheel goes round, and this may be made to revolve automatically once a minute or once an hour according as the tap of water runs fast or slow. The washing trough is, moreover, provided with a siphon arrangement for changing the washing water.

A very practical cutting board, for cutting paper, is to be seen in the same building, which is no more than a block of beech; the grain of the wood being end on, it presents a most durable and perfect medium for cutting upon.

Mr. England stores some of his negatives—of which there are hundreds of thousands at St. James's Square—in ordinary rack boxes, and some braced together (with a sheet of blotting paper between) by elastic web bands. If a negative is coated with proper varnish, there is no fear of the film rising, is Mr. England's opinion, and this is the way he makes his varnish. A pound of the best seed lac is put into a quart bottle of methylated spirit; the lac is shaken up from time to time, but the solution is not heated. After two or three days, the spirit will have taken as much lac as is necessary, and the clear liquid is poured off. The residue may either be thrown away, or employed again with fresh lac.

For mounting, Mr. England employs only gum—the very best white gum—of which solutions are freshly prepared. Mounts have given him a great deal of trouble, and now he tests for antichlor or hyposulphite before he trusts to new cards; he has a liking for enameled boards. His stock of prints, which is obviously very extensive, is kept, however, in an unmounted condition. A large staff of girls find employment in these mounting and finishing rooms.

As our readers are aware, Mr. England is *facile princeps* in the preparation and manipulation of gelatine plates. His method of emulsification has already appeared in these columns, but a brief description of a drying cupboard he employs will be read with interest. An elaborate drawing of this cupboard is, we believe, shortly to appear in print, so we confine ourselves at present to a rough sketch of it in



A is an inch iron tube, kept hot by gas jet, C; B is an outer tube two or three inches in diameter; D are diaphragms to prevent light from entering above or below through outer tube; E, E are wires upon which the plates rest; the arrows indicate the air currents.

section. An inch iron tube runs right through the center of the cupboard, heated by means of a tiny bead like jet of gas. A larger tube incloses this inner tube on entering and leaving the cupboard, and the warm air, which is provided with ingress and egress through the larger tube, passes over the gelatine plates, which rest in a horizontal position on wires stretched across the cupboard.

As gelatine runs at a temperature of about 90° Fahr., it is necessary that the air of the drying cupboard should average between 60° and 80° Fahr., and this is easily maintained in Mr. England's clever arrangement.

Mr. England is confident as to the great future for gelatine, and has secured most perfect results with films many months old. His formula for intensifying is that suggested by Captain Abney, the plates, after a thorough washing, being treated with

Mercuric chloride	20 grains.
Ammonium chloride	20 "
Water	1 ounce.

A second washing follows and then treatment with dilute ammonia.—*Photographic News.*

THE DEVELOPMENT OF GELATINE PLATES.

THE days of ammonia development are numbered. As the wet collodion plate has been elbowed from the front rank by the dry gelatine film, so ammonia must give place to the ferrous oxalate developer. There is no question about it.

There is an idea that oxalate development is complicated, and that the developer itself is difficult to make. This, we may state at the outset, is mere prejudice and nothing more; and, when we add that there are no unpleasant fumes—ammonia is very unpleasant in a small confined place—that the development is effected much more quickly, and that, moreover, the result is far more apparent to the worker than in the case of ammonia solutions, we think we have said enough to establish our enthusiastic opinion of the newer developer.

We have tried several oxalate developers, and pronounce emphatically in favor of that proposed by Dr. Eder, a name already sufficiently well known to command the respect of photographers. This developer has given the most satisfactory and uniform results, and it is very easy of production. You have simply to dissolve two salts, and mix these solutions together. Dr. Eder's formula is as follows:

SOLUTION A.

Neutral oxalate of potash	260 grammes.
Water	1,000 "

SOLUTION B.

Sulphate of iron	100 grammes.
Water	300 "
Sulphuric acid	2 to 4 drops.

Multiply by 15½ to bring grammes into grains.

The two solutions, A and B, are kept in stock, and when required for development, three volumes of A are mixed with one volume of B.

A more simple developer can scarcely be imagined, and considerable experience of its action permits us to speak of it in the highest terms. The sulphuric acid specified is not sufficient to render the developer acid, but in experimenting we have worked with a perfectly neutral developer, and without materially affecting the result. In these circumstances we hardly think that the term alkaline development is applicable any longer to this treatment.

The negatives approach very much in appearance those from wet plates; there is an absence of all brownness, and we have never had occasion to intensify. Again, the sensitiveness of the plates is greatly improved, as will be seen at the first comparative experiment made with the ammonia and oxalate developer. To push the test of sensitiveness, we made the following delicate experiment. A series of luminous paints applied to a deal board were exposed to sunlight, and then brought into the dark room. They all presented the well-known violet phosphorescence of a more or less vivid character. A gelatine plate was exposed for a period of ten minutes in a stereoscopic camera (lenses Dallmeyer's No. 1 B), and the plate being subsequently cut in two with a diamond, half was put into a strong ammonia and pyrogallic bath (with freshly prepared pyrogallic solution), and the other into Eder's oxalate developer. Before five minutes had elapsed; the Eder plate showed a perceptible picture, but a quarter of an hour's sojourn in the ammonia bath failed to give but the faintest image.

Finally, the oxalate developer, while you can see the result so much better, is more accommodating in its action. A stereoscopic plate was exposed for two seconds in the studio and cut into halves; one half was permitted to remain in the bath for five minutes, and the other for half an hour. The first was the better negative of the two, but in the second there was not the *least trace of fog,* neither had the soft gradations been spoilt; the only difference was that the latter plate was very dense, and required a good deal of printing.

We may safely say that any of our readers who try a good oxalate developer, such as Dr. Eder's has proved in our hands, will never have recourse again to ammonia.—*Photographic News.*

CURARE AND OTHER CURES FOR HYDROPHOBIA.

THERE was published in *The World* a little while ago an interesting communication from Dr. John W. Green on the subject of "Hydrophobia and Woorara"—*curare,* in which he said that experiments had led him to the belief that the proper dose of the substances used hypodermically was about the thirteenth of a grain, a dose that was to be repeated often till the proper effects were produced. The woorara, he said, quieted spasms and reduced all nervous irritability, thus giving the system time to eliminate the hydrophobic virus, and as to its use, he added:

During the past three years some of the physicians connected with the German hospitals have reported a few cases where this recover has been tried. In all but one case complete recovery ensued, and in the case that ended fatally I imagine from the report of it that the woorara was not used faithfully and understandingly. If it will, however, save 50 per cent. of those attacked, it is better than losing all of the affected. In taking account of the cases reported which I have seen, making altogether four, there has been one death. This is a percentage of 75 in favor of woorara.

More recently, an article in the same paper states that Dr. Etheridge, of Chicago, has been experimenting with curare—the secret of manufacturing which, by the way, Jovert bought last year from the Amazonas Indians—upon a hydrophobic patient, with what success we are unable as yet to say. According to the German papers, Dr. Offenberg, of Dusseldorf, has cured a woman bitten by a mad dog by a hypodermic injection of twenty centigrammes of the agent; on the other hand a Russian experiment has failed almost signally. Nine persons were bitten by a rabid wolf in the hamlet of Bogoljubow, in the Wladimir district, and were taken to the hospital, where five of them died in dreadful agony soon after their admission. The doctors resolved to try curare in the other cases. This was administered at Wladimir to the remaining four persons who had been bitten by the wolf, and they all died, but without experiencing the preliminary torture of hydrophobia. This was, of course, something gained, though not much; in the absence of any details it is impossible to say to what cause the startling result was fairly to be attributed. Two other Russian physicians, Schmidt and Ledeben, are said to have cured the case of a little girl of twelve by causing her to inhale oxygen. Our old friend, the elecampane cure—a third of an ounce stewed in a third of a pint of milk and taken fasting every other day for eighteen days—has been going the round of the press, in company with the Russian broom-seed tea cure, and the madstone, which last proved conspicuously useless in the case of the Hon. O. F. West, of Senatobia, Miss. Another treatment that has been recommended is bathing with warm vinegar and water, and then pouring a few drops of muriatic acid on the wound; still another is the application for from six to ten minutes of a sponge dipped in equal parts of chloroform and concentrated ammonia. The case of Crosse has been revived, who, having been bitten severely by a cat that died the same day from hydrophobia, cured himself by mere mental resolution after pains had reached his shoulder and spasms had shot through his throat at sight of water. The specific preventive of the pious peasants of the Ardennes is—for the dog a piece of bread blessed at mass on St. Hubert's Day; for the man wearing a ring or medal consecrated at St. Hubert's shrine. It was to this same shrine of St. Hubert in Ardennes that, as Chapella tells us, the Princess of Vandémont, having been bitten by a mad dog, did make a pilgrimage in a green carriage, dressed all in green. At the spring, having put on a green stole and listened to a chapter of the Gospel according to St. John, she drank a glass of water and returned home to live fourteen years, while two less pious friends, bitten by the same dog, died of hydrophobia. Perhaps, however, the virus was still lurking undeveloped in her system, for in June last Mr. Samuel J. Culver died at New Haven, Conn., of a bite received twenty years before, a case even more terrible in some respects than that of Frank Shields, of Bloomington, Ind., who on the 1st of November was put in jail to prevent him from doing violence to himself and friends. He had been roaming the woods, yelping like a hound in the chase; and on meeting teams on the road would seize the horses and bite them like a dog. He was said to have been bitten by a dog ten years ago.

M. Galtier has recently made some valuable experiments from which he draws the conclusion that the saliva of a mad dog obtained from the living animal and kept in water, continues virulent five, fourteen, and even twenty-four hours afterwards. Thus the water of a vessel in which a mad dog may have dropped some of its saliva in attempting to drink should be considered virulent at least twenty-four hours; and as the saliva of a mad dog which has succumbed to the malady or has been killed does not lose its properties through mere cooling of the body, it is important in examining the cavities of the mouth and throat after death, to guard against the possible danger of inoculation. M. Galtier tested rabbits with regard to rabies, and found it transmissible to them from the dog; also, the rabbits' rabies from them to animals of the same species. The chief symptoms are paralysis and convulsions. The animal may live from a few hours to four days after the disease has declared itself. M. Galtier found salicylic acid, injected daily under the skin, powerless to prevent the development of the disorder in rabbits.

M. Raynaud, experimenting in the same direction, ascertained the effects of inoculation of the rabbit from man in

the hydrophobic state. A man in that state was brought to the Lariboisiere Hospital, having been bitten in the upper lip by a dog forty days previously. He had had the wound cauterized two hours after the accident, and had thought himself quite safe till some of the usual hydrophobic symptoms appeared. The day before his death, in a quiet interval, he yielded himself with the best grace to the experiments in inoculation which were made with his blood and his saliva. The result of inoculating the rabbit with the blood was negative (as in the great majority of previous cases of inoculation with blood of animals under rabies). But with the saliva it was otherwise. A rabbit inoculated in the ear and abdomen, on October 11, began to show symptoms of rabies on the 15th, being much excited and damaging the walls of its cage, while it uttered loud cries and slavered at the mouth. Then it fell into collapse and died the following night. The rabbit's body was not dissected till thirty-six hours after death, and further experiment was made by taking fragments of the right and left submaxillary glands, and introducing them under the skin of two other rabbits respectively. These two rapidly succumbed, one on the fifth, the other on the sixth day (becoming visibly ill on the third); neither passed through a furious stage, however, and the predominant feature was paraplegia (a form of paralysis). The important practical result is that human saliva, such as caused rabies in the rabbit, is necessarily virulent, and would probably have corresponding effects on man; so that it should be dealt with cautiously, and that not only during the life of the person furnishing it, but in post-mortem examinations.

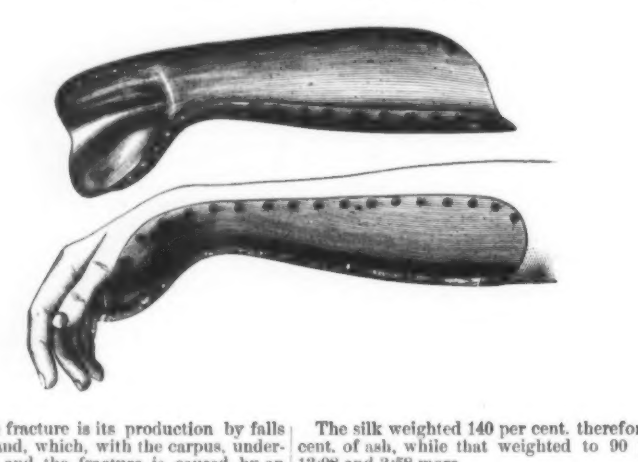
THE TREATMENT OF FRACTURE OF THE LOWER END OF THE RADIUS.*

By R. J. Levis, M.D., Surgeon to the Pennsylvania Hospital and to the Jefferson College Hospital.

The correct nature and mechanism of the ordinary form of fracture of the lower end of the radius is now, after much controversy, generally admitted and properly comprehended. With this proper understanding the indications of treatment become rational and decisive.

In the usual and very characteristic fracture of the carpal end of the radius the primary line of fracture is, with little tendency to deviation, *transverse* in direction. Associated lines of fracture are generally those of comminution of the lower fragment, and are caused by the upper fragment being driven vertically into it and splitting it, usually in directions towards its articular surface.

The displacement of the lower fragment is towards the dorsal aspect of the forearm, and its articular surface is inclined in the same direction, abnormally presenting backwards and upwards.



The mechanism of the fracture is its production by falls upon the palm of the hand, which, with the carpus, undergoes extreme extension, and the fracture is caused by an *act of leverage* or *transverse strain.* This direction of force has also been called *cross-breaking strain.*

In this fracture actual displacement of the lower fragment may not exist at all, or it may be to the extent of complete separation from contact of the broken surfaces, varying with the amount of force applied, and with the retaining influence of the surrounding dense structures

The first essential of the treatment of fracture of the lower end of the radius is the *complete reduction of the displacement.* The action of replacement must be directed to the lower fragment itself. The reduction of the fracture can usually be thoroughly effected, under anæsthesia, by *strong extension applied to the hand, associated with forced flexion of the wrist, and with pressure applied directly on the dorsal surface of the lower fragment.* Unless vertical splitting or comminution of the lower fragment exists, the maintaining of partial flexion of the wrist, with pressure of a pad on the dorsal surface of the fragment, will prevent return of deformity.

With the object of retaining the apposition of the fractured surfaces, by overcoming displacing forces, I have practiced for many years on the principles involved in the splint here illustrated, the application of which will not require much description.

In the treatment of fracture of the lower end of the radius it is essential that proper allowance be made for the curvature of the anterior or palmar surface of this part of the bone. This is insured in the splint which I have devised, which follows correctly the radial curvature; and the fixing of the thenar and hypothenar eminences of the hand in their moulded beds, maintains the splint immovably in its correct position with reference to the radial curve.

To neglect of complete primary reduction of the displacement of the lower fragment, and to inefficient restoration and retention of the normal radial curve, are due the frequent unfortunate sequences of this fracture.

The splint is made of copper, so as to be readily conformable by bending to suit the peculiarities of size and form of forearms. The series of little pointed elevations along the edge is for the purpose of keeping the bandage from slipping. It is tinned to prevent oxidation.

The splint will usually fit the forearm so accurately that but little padding will be required, and a piece of woven lint, or of cotton or woolen flannel is all that is necessary for its lining. No dorsal splint is needed, but, as before referred to, a small pad will, in most cases, be required over the dorsal surface of the lower fragment. For retention of the splint an ordinary bandage, two inches and a half to three inches wide, is all that is necessary.

This splint has the merits of being applicable to all cases of fracture of the lower end of the radius, and also to many other injuries involving the forearm and wrist; it is almost indestructible, and, as now supplied, is very inexpensive. It may be obtained by addressing any of the leading surgical instrument makers.

* From the Transactions of the Medical Society of the State of Pennsylvania.

WEIGHTED BLACK SILKS.

The Chamber of Commerce of Crefeld handed over to the town analyst, Dr. Königs, last year, a small sample of a black silk tissue of French origin, belonging to a lot which took fire on board a Bremen steamer, as it is supposed, spontaneously, with instructions to examine it chemically and to report on its inflammability.

1.—PRELIMINARY EXPERIMENTS.

(a) *Direct determination of the weighting.*

The first question to be solved referred to a determination of the weighting. Before going to work upon the sample required to be examined the possibility of obtaining a satisfactory result had to be ascertained. Experiments were made with the following black silks, the amount of weighting on each of which was given. But the results were unfavorable, as in most heavily weighted sorts the results did not agree among themselves, and did not correspond with the stated weighting, 140 per cent. (100 lb. raw=240 dyed).

The best method seemed to strip the silk with alternate baths of cold soda lye and boiling oxalic acid, washing with water, drying, and weighing.

A, Organzin,	42¼	per cent. gave	49	per cent.
B, do.	45¼	" "	50	"
C, Trame souple,	140	" "	132, 185, 119	"

Or very fluctuating results.

D, Trame souple,	90	" "	84	"

These results confirmed the assumption that nothing could be done in the way of determining the weighting, and that the small specimen received for examination would have been uselessly sacrificed.

(b) *Proportion of the ash to the weighting.*

Heavy weighting is not always connected with a high percentage of ash. A determination of the ash of the four samples above mentioned showed:

A, Ash 10·7 per cent.
B, " 11·46 "
C, " 10·4 "
D, " 13·98 "

The silk weighted 140 per cent. therefore showed 10·4 per cent. of ash, while that weighted to 90 per cent. showed 13·98 and 3·58 more.

The cause of these discrepancies was found to be as follows:

The ash of C consisted exclusively of ferric oxide, the coloring matter consisting of tannin and iron. The ash of D consisted chiefly of oxide of tin; and since, as appears on further investigation, the tin compounds of tannin contain a considerably smaller proportion of tannin than the corresponding iron compounds, oxide of tin represents a less amount of weighting than does a similar quantity of oxide of iron.

(c) *Ash of raw silk not dyed.*

E, Raw silk, not ungummed, ash=1·1 per cent.
F, Raw silk ungummed=0·77 per cent.

(d) *Proportion of the constituents of the ash to the compounds from which they were derived.*

It appeared desirable to ascertain the proportion of ash to the compounds formed in black dyeing by means of the tannin of galls, of extract of chestnut and of catechu, and of the organic matter of logwood. For this purpose special experiments were undertaken.

Six different samples of extract of chestnut, the astringent body most employed in weighting, served to prepare the compounds of tannin and iron, copperas being used.

The black coloring matters (not formed on the fiber) were dried in a current of carbonic acid, and showed that 1 part of oxide of iron represented from 4·48 to 5 parts of black color (average 4·696), according to the quality of the extract. If instead of copperas, black liquor is used along with the extract of chestnut, the proportions were 1 part of iron to 4·8 and 1 to 4·73 of color.

Similar experiments were then tried with catechu, along with chestnut. The proportions found were 1 to 5·1.

The compounds of tin with catechu and chestnut give very different proportions, that is, 1 part oxide of tin represents 1·85 of color when the former is used, and 2·22 when the chestnut extract is employed.

If the black liquor is used undiluted, say 14° Baumé, the proportion is only 1 part of oxide of iron to an average of 3·12 of the compound formed.

Black liquor with gall nuts yields 1 to 4·67, and with catechu 1 to 5·11.

When the black silk dyer has the legitimate object of dyeing silks without adding to their weight he uses chiefly persalts of iron, the proportions then being 1 to 4·7 with chestnut, and 1 to 7·23 with catechu.

In Prussian blue from yellow prussiate, the proportions are 1 to 1·53, and with red prussiate 1 to 1·49.

After these proportions were ascertained it became possible to execute an approximate quantitative analysis both of the weft and the warp of the small French sample.

Moisture, fatty matter, and gum were determined in the warp by well known methods. The Prussian blue was stripped with soda, reprecipitated by the addition of an acid, filtered, washed, and incinerated with the aid of oxidizing agents, thus leaving oxide of iron, from which the Prussian blue existing on the fiber was calculated according to the proportions ascertained above. The warp was found weighted to the extent of 52·35 per cent. (100 raw silk=152·35 dyed), and weft to 157 per cent. (100 raw silk=257 dyed). Upon these analytical results and calculations the following remarks are necessary. According to M. Marius Moyret—the first authority, doubtless, in the world upon this question—when a manufacturer sends to a dyer 100 lb. of raw silk, with the stipulation that, say, 200 lb. are to be returned, it is an error to suppose that the dyed goods consist of 100 lb. of real silk and 100 lb. of coloring and other matters plastered on. The custom of the trade calls such silks weighted to 100 per cent., but if we look more closely we shall see that the weighting amounts to a good deal more, and that the real silk is a good deal less than is represented. The first step, the so-called boiling or ungumming, *reduces* the weight of the silk by a variable quantity, which is rarely less than 20 per cent. Hence, therefore, the 100 lb. of silk falls to 80 lb.; and to raise the weight again to 200 lb. stipulated the dyer must plaster on, not merely 100 lb., but 120 lb. of promiscuous matter. Hence the silk is weighted, as may be easily calculated, not to the extent of 100 per cent., but of 150. Therefore it follows that the results of the correct analysis of a sample of weighted silks will greatly exceed the degree of weighting as stated by the manufacturer or merchant. To find the quantity of the original raw silk as it existed before the dyer took it in hand is simply impossible, except it could be ascertained how much the silk had lost in the preliminary operations before the dyeing, in the true sense of the word, was begun. The author further states that in weighted silks the color lies irregularly, and is thicker in some parts than in others, and that it rubs off in the form of powder. Hence it follows that if small portions, say three or five grains each, are taken for analysis, the results obtained may naturally vary.

Dr. Königs then proceeds to describe his experiments on the spontaneous combustibility of weighted silks. Unfortunately his operations do not seem to have been conducted under conditions identical with those occurring or likely to occur in practice. We do not find that he left large heaps of the weighted goods undisturbed for some length of time, and observed whether any spontaneous elevation of temperature occurred, which might ultimately end in actual combustion. On the contrary, he seems to have heated small portions of silk to different temperatures, in order to see if they would then take fire. He writes: "Various attempts to bring warp, weft, or the tissue itself to a state of combustion by gently heating to 212° to 392° Fahr., gave negative results." We do not doubt it, but this seems to us altogether beside the question. If we were to take an ounce of hay and heat it to the temperature of boiling water, should we find it take fire? Certainly not; yet this negative result would not warrant us in asserting that a ton of damp hay, left to itself, is in no danger of combustion.

Dr. Königs makes an observation which fully shows that the inflammability of silk increases with the amount of weighting. He states that the weft (which was the more heavily weighted), if brought in contact with a flame, took fire more easily and went on burning longer than the warp.

Until a very different method of experimentation shall have confirmed the negative results of Dr. Königs, we shall still hold railway and insurance companies, shippers, etc., fully justified in treating weighted silks as dangerous articles.—*Correspondenz-Blatt des Vereines Analytischer Chemiker—Chemical Review.*

VEGETABLE RESPIRATION.

This paper is written not with the view of presenting anything particularly new, but for the purpose of endeavoring to correct the common yet erroneous ideas concerning plant respiration. The leaves are usually spoken of as the lungs of plants. This term would not be objectionable were it not accompanied by a description, or by the conception of a process that is carried on in the leaves, which is anything but a respiratory process. Respiration consists of the inhalation of air for the purpose of supplying oxygen to the animal or vegetable tissues, and the opposite act of exhaling air for the purpose of taking away from the tissues carbonic acid, the carbonic acid being in the form of gas.

The process that takes place in the leaves of plants that is usually called respiration is one in which the leaves absorb carbonic acid gas from the atmosphere and give off oxygen.

We often hear parks and collections of trees spoken of as the lungs of the city, and the reason given for that designation is that the leaves take carbonic acid from the atmosphere and thus purify it, at the same time giving off oxygen which is essential to the well-being, yea! even to the existence of men and animals, and, I might add, *plants.*

This process is not respiration, but digestion. Food is what plants acquire by this act, for the carbonic acid thus withdrawn from the atmosphere is changed into carbon by a true digestive process, which, like other nutrient products of digestion, becomes incorporated into the substance of the tissues.

Let us examine this process for a moment and see how it is conducted. The carbonic acid gas of the atmosphere comes into contact with the chlorophyl or coloring substance of the leaves, and by its action the gas is decomposed—that is, the carbon and the oxygen which compose the carbonic acid are separated from each other, the carbon becoming fixed in vegetable structure, while the oxygen, being set free, escapes into the atmosphere. The supply of carbonic acid in the atmosphere is constant; yet although the carbonic acid is ever present, and the leaves of plants are continually immersed in an atmosphere containing carbonic acid, yet this process is not continuous, but intermittent. It takes place only during the day, and is suspended during the night. This intermittent property is owing to the fact that the stimulus of light is requisite to enable the chlorophyl to separate the carbon and the oxygen. Artificial light will not excite this action, and hence plants sleep in the presence of artificial light. Moonlight, which is only reflected sunlight, may effect this change to a very small extent. But, broadly stated, sunlight is necessary that the chlorophyl may exert its decomposing powers. This process goes on at a speed corresponding with the intensity of the light. Hence tropical plants absorb carbon more rapidly than do those of temperate regions, and these again more rapidly than do those of colder climates. It is for this reason that tropical plants, and especially tropical fruits, when

grown under glass in northern latitudes, are inferior to those matured in their native habitat. The required temperature can be supplied artificially, but the amount of sunlight is insufficient for the requirements of these plants, and artificial light cannot be substituted. The agency of sunlight in vegetable growth is therefore directed to the fixation of carbon in the vegetable structure; and this is one reason why animals are not so dependent upon its constant presence. Experiments show that the chemical change which results in the fixation of the carbon and the liberation of the oxygen is due to the action of sunlight. "Put a fresh leaf into water exposed to sunlight, and oxygen gas will escape from it in bubbles. Shade it, and the disengagement immediately ceases. The greater the force of the sun's ray, the greater the speed at which the vegetable machinery is driven."

The proportion of oxygen in carbonic acid is twice as great as is that of carbon; and the proportions are not changed by the conversion of carbonic acid from a crystalline to a gaseous form. Hence it is evident that the rapid absorption of carbon that takes place under the stimulus of sunlight is accompanied by the evolution or liberation of a much larger amount of oxygen.

It is well known that carbon is one of the principal substances that enters into the composition of vegetable tissue. It is also known that the chief source of the carbon is the atmospheric air.

Now, as carbonic acid is not an element of pure atmospheric air, the question naturally arises, from what source does the atmosphere derive its supply? The common answer is, it is exhaled by animals. That is true; but did not plants exist upon the earth before animals? And if so, whence came the carbonic acid that these earlier plants fed upon? I shall not attempt to discover the source from which those very simple and lowest forms of vegetable life which first appeared upon our earth derived their carbon. It may have been furnished by some method unknown to us, and that is yet to be discovered. The point that I wish to bring to your notice at this time is, that carbonic acid gas is exhaled by plants as well as by animals—that true *vegetable* respiration is attended by the absorption of oxygen and the giving off of carbonic acid equally with *animal* respiration, the difference being only in degree.

That plants imbibe oxygen and emit carbonic acid has been abundantly shown by careful experiment. If we deprive a plant of oxygen it perishes, and although an undue accumulation of carbonic acid in the atmosphere is not so destructive of vitality with plants as in the case of animals, yet a healthy condition of every plant demands that provision shall be made for the escape of carbonic acid. Plants cannot long survive in an atmosphere loaded with carbonic acid gas, but soon suffocate and die, and this less quickly but just as surely as in the case of animals.

The imbibition of oxygen and the emission of carbonic acid constitute vegetable respiration, just as the same process in animals constitutes animal respiration.

Having shown that the vegetable process commonly called respiration is a digestive proceeding, let us turn our attention to the real act of vegetable respiration. This act is performed by the agency of the entire surface of the plant, which is surrounded by atmospheric air; hence by the bark and leaves. Actively by the leaves and the fresh bark of young shoots, and less actively, but still constantly, through the older bark which covers the trunks and larger limbs of trees.

Beneath this older bark is a layer of young bark, which, not being in actual contact with the air, is somewhat hindered in its respiratory functions by the covering of older bark which surrounds it. This covering is, however, very porous, and air passes through it without serious difficulty.

The epidermis or skin of plants is composed of cellular tissue, and envelops the entire plant except the stigma of the flower and the terminal or absorbing points of the roots. The cells composing the tissue contain air, and the air is renewed or changed to an extent equal to the requirements of respiration. These air cells correspond to the air vesicles in the lungs of animals, and are the vehicles through which the plant is supplied with oxygen. Usually there is but one layer of these cells that is engaged in discharging the respiratory function, but not unfrequently there exist two or more layers. These air cells perform a double office, and while a single layer is sufficient for the performance of the respiratory function, the additional layers are useful in the additional function above mentioned. This second office prevents a too rapid evaporation of moisture from the substance of the plant; and when more than one layer is present, these layers being disposed one over the other, the hinderance to evaporation is increased. Plants having several layers suffer less from a deficiency of moisture, owing to diminished evaporation. For example, the oleander has the unusual number of four layers of cells, and, for that reason, endures drought to a remarkable extent.

Besides these air cells there are openings between the cells, which admit air and water to pass through the epidermic covering, and thus reach the underlying tissue. These openings or channels, however, are not constant. Their orifices are mostly open during the day, but close at night, when access to the underlying tissue by this means is suspended. Sunlight has the effect of opening these orifices, and in its absence they generally close.

These channels always connect with passages in the tissue composing the substance of the plant, called intercellular passages, which lead into the compact tissue, and thus admit air and water into the deeper parts. Their orifices are very abundant all over the leaves, except on the midribs and veins, and also on the young shoots. A hundred thousand of them may occur within a square inch of surface. The similarity between leaf and bark is such that the leaf may be considered as a broad expansion of newly-formed bark.

Respiration takes place through the day by means of these openings, and also by means of the air cells. But during the night, when the orifices of these channels are closed, respiration takes place only through the air cells. This latter process goes on continuously day and night, summer and winter, for a plant cannot long survive the suspension of the respiratory office. The object of respiration is, first, to supply oxygen for the use of the plant; and, second, to convey away the carbonic acid gas that is liberated by the changes which occur in plant food after it has been absorbed by the roots.

During the growing season more carbonic acid gas is absorbed by the leaves than is exhaled by plants; but the respiratory process, as I have said, goes on continuously, and the carbonic acid gas, exhaled in the intervals of growth, is distributed over the earth by winds and other atmospheric currents. The proportion in the atmosphere is thus equalized. During the growing season the roots absorb water containing more or less of plant food in solution. This fluid we call sap. It is carried to the leaves, and there undergoes digestion. Starch is a result of this process, but starch is not available as plant food. To render it available it must be changed to sugar. This is effected by the oxygen supplied by respiration, especially during the winter rest. The oxygen derived from the air unites with a portion of the carbon contained in starch, and in that manner converts the starch into sugar; the resulting carbonic acid, formed by the union of the oxygen with the carbon withdrawn from the starch, is exhaled through the air cells, and thus returns to the atmosphere as carbonic acid gas.

Thus the great stores of starch that are accumulated through the growing season are gradually converted into sugar through the agency of respiration, while the plant is in a state of comparative rest. When spring returns, the starch laid up during the previous year has become soluble by reason of its conversion into sugar, and is ready to be used for the nutrition and growth of the plant. This process takes place in all perennial plants, but is more conspicuous in some plants than in others. It is notably the case with the maples, and especially with the *Acer saccharinum* and *Acer negundo*.

The bark of evergreens is not so well suited for the respiratory process, and for that reason the leaves are retained continuously that respiration may not be interrupted.—*Missouri Dental Journal.*

THE VOLATILE OIL OF ALMONDS.

By WM. L. DUDLEY, Prof. of Analytical Chemistry and Toxicology, Miami Medical College of Cincinnati, Ohio.

ON depriving bitter almonds of their fixed oil, by pressure, and macerating the pulverized cake in six or eight times its weight of cold water for a day or two, at a temperature of about 50° C. (122° F.), and then distilling, the volatile oil of bitter almonds will be obtained. The yield varies considerably, but is generally in the neighborhood of 1 per cent.

This oil does not pre-exist in the almonds, but is produced by the decomposition of amygdalin under the influence of a ferment called synaptase or emulsin, present only in bitter almonds. Together with this volatile oil, hydrocyanic acid (prussic acid) and glucose (grape sugar) being at the same time formed. This reaction should first be effected before distillation is resorted to; and while digesting, the temperature should not be raised too high, since there is liability of coagulating the emulsin and thus rendering it ineffective. Distillation by superheated steam is preferable to the use of the naked fire, in order to avoid empyreuma.

The volatile oil of almonds is known in commerce under the names of oil of bitter almonds, essence of almonds, essential oil of bitter almonds, and oleum amygdalæ amaræ. When perfectly pure, it is identical with benzoic aldehyde, having the formula C_7H_6O. It is colorless or yellowish, limpid, turning a ray of polarized light to the right, of a peculiar, pleasant odor, and a burning aromatic taste. Its specific gravity is 1·043 to 1·07, usually 1·06 (Hirsch). It boils at 180° C. (356° F.). It is soluble in about 30 parts of water, and in all proportions of alcohol, ether, chloroform, carbon bisulphide, and essential and fatty oils. By the action of light and air, it is gradually oxidized into benzoic acid, which crystallizes out on standing. The ethereal or volatile oil is officinal in the French, Swiss, and Norwegian Pharmacopœias.

The crude oil contains variable quantities of benzimid ($2C_7H_6O.C_7H_5(CN)_2$), benzoin ($C_{14}H_{12}O_2$), benzoic acid ($C_7H_6O_2$), and hydrocyanic acid (HCN). It may be forced from the latter by agitating the sample with mercuric oxide and water, or with lime and ferrous chloride, followed in either case by distillation of the oily layer.

Hydrocyanic acid is a frequent and dangerous impurity in the volatile oil of almonds, and is often present to the amount of eight per cent., and sometimes double that quantity, or, in other words, from four to eight times the strength of the hydrocyanic acid of the British and United States pharmacopœias. Its presence may be detected as follows: Agitate the sample of oil with water for a few minutes, and to the aqueous liquid add ferric chloride, ferrous sulphate, and finally a solution of caustic soda. Acidulate the liquid with hydrochloric acid, and if a bluish-green coloration or blue precipitate (Prussian blue) is formed, it indicates the presence of hydrocyanic acid. In estimating the quantity of this acid present, the liquid should be titrated with a standard solution of silver nitrate. Benzoin is a solid camphor-like body, and occurs most largely in samples of oil of high density, in the preparation or purification of which a high temperature has been employed. It gives a purple color with strong sulphuric acid, while the bitter almond oil gives a crimson coloration, which becomes brownish on exposure to the air.

The most frequent adulterations are alcohol, nitrobenzol, chloroform, and essential oils. The presence of alcohol may be ascertained by agitating the oil with about three times its volume of concentrated nitric acid, and gently warming the mixture by placing the test tube in warm water. If the oil be pure no reaction will take place; but if it contains more than three per cent. of alcohol, effervescence will occur, with the evolution of yellowish nitrous fumes. Blyth recommends the addition of fuming nitric acid, and if 0·08 per cent. of alcohol is present, there is immediately strong effervescence.

Nitrobenzol, which is known in commerce under the name of "essence de mirbane," is indicated when the oil has a specific gravity higher than 1·07, and is not completely soluble in a solution of bisulphate of potash; but sometimes either alcohol or chloroform is added with the nitrobenzol, in order to lower the specific gravity. Nitrobenzol, by the action of reducing agents, is converted into aniline, and in the detection of it, this reaction may be taken advantage of, as follows: To 1 part of the oil add 10 parts of dilute sulphuric acid (specific gravity 1·117) and 10 parts of granulated zinc, agitate frequently for about two hours, pass through a moist filter, add to the filtrate a crystal of potassium chlorate, and a drop of concentrated sulphuric acid. If a violet or red color is produced, it indicates the presence of nitrobenzol. Maisch proposes the following method; One gramme of the oil is dissolved in twelve times its volume of alcohol, 0·75 gramme of fused potassium hydrate is added, and the whole heated until the liquid is diminished about one-third. The pure oil on cooling is of a light brown color, and dissolves entirely in water; but if nitrobenzol is present, the residue is brown, crystalline, and insoluble in water. Another test utilizes sodium; Pure almond oil, when treated with sodium, gives white flocks; if nitrobenzol should be present, the sodium is immediately covered with yellow or brown flakes, according to the amount of adulteration; if the percentage rises as high as 0·30 to 0·50 per cent., the whole liquid after a minute becomes thick and opaque.—(Dragendorff.)

Essential oils may be detected by the sodium bisulphate test: If a little of the oil be dropped into a warm aqueous solution of sodium bisulphate, of from 1·24 to 1·26 specific gravity, shaken, and then diluted with hot water, it is completely dissolved if pure, while if it contains other essential oils, complete solution will not take place.

Chloroform may be easily detected by distilling a small quantity of the suspected oil from a test tube placed in a water bath, kept at a temperature not exceeding 65° C. (149° F.), when the chloroform, if present, will distill over, and on mixing a little iodine water with the distillate, the iodine will be absorbed, and separate with a rose color, if alcohol is absent.

Artificial benzoic aldehyde (artificial oil of bitter almonds) is prepared by the action of chlorine on hot toluene (C_7H_8), by which the chloride of benzyl (C_7H_7Cl) results, and this yields benzoic aldehyde on distillation with nitrate of lead and water in an atmosphere of carbonic acid. It is free from hydrocyanic acid, but is liable to retain traces of chlorine and bromine compounds.

The oil of bitter almonds of commerce often exhibits poisonous properties owing to the hydrocyanic acid which it contains. One drop has been known to kill a cat, and seventeen drops have produced serious and even fatal effects on man. It is one of the best forms in which hydrocyanic acid can be administered medicinally.

The annual importation of this oil into the United States amounts to about 1,500 to 2,000 pounds.

VALUE OF ZINC POWDER.

By V. DREWSEN.

IF zinc powder is brought in contact with sulphuric acid and acid potassium dichromate, using of the latter more than twice the quantity theoretically needful, the nascent hydrogen reduces the chromic acid to chromic oxide. To 1 grm. zinc powder is added 100 c.c. of a solution of pure potassium dichromate (40 grms. to 1 liter), and two quantities of dilute sulphuric acid, each of 10 c.c., are introduced successively, stirring well all the time. As soon as the zinc powder is dissolved, with the exception of a small residue of insoluble matter which is almost invariably present, an excess of sulphuric acid is added, and 50 c.c. of a strong solution of iron sulphate (200 grms. to 1 liter), the action of which upon the solution of the dichromate has been determined previously. A slight excess of the same liquid is then cautiously added, titrating afterwards back with the solution of acid potassium dichromate until a drop of the liquid is no longer turned blue by potassium ferricyanide. The quantity of potassium dichromate used, if multiplied by 0·66113, gives the metallic zinc present in the sample of zinc powder. The results obtained agree well with those furnished by the method of Fresenius, *i.e.*, combustion of the hydrogen by means of copper oxide, and weighing the water formed. For pure zinc the process is not applicable.—*Zeitschrift Anal. Chemie.*

CARMELOINE.

THIS new color has been used with great success in some establishments both for printing and for dyeing wool and woolen piece-goods.

It yields cheap and fast browns; the samples appended in the *Teinturier Pratique* are got up with a little alum and sulphuric acid, and cost about 2d. per 35 oz.

Carmeloine may be mixed with extract of indigo, orchil, and all the coal-tar colors capable of bearing the contact of acids. Its price is about 10s. per kilogramme = 4s. 7d. per lb. We understand that it may be obtained from the firm of Max Singer & Co., Tournai, Belgium.

PETROLEUM AND COAL BENZINES.

THE fact that naphtha, benzine, and benzol are not defined with sufficient clearness was brought under notice by the labors of the Berlin commission for the classification of merchandise. In consequence of the protectionist law of July 15, 1879, mineral oils fit for lighting purposes were made subject to a duty of ten marks per 100 kilos, whilst tar oils and mineral oils not fit for lighting are still admitted duty free. According to Dr. Häusserman only a very small quantity of American petroleum arrives in Europe in its crude, unpurified state. The greater part has been treated with concentrated sulphuric acid and submitted to fractional distillation. It is thus, in the first place, resolved into three products, *i. e.*, naphtha, refined petroleum, and petroleum dregs. The naphtha, which forms from five to ten per cent. of the crude petroleum, is a clear, colorless, mobile liquid, which boils at from 122° to 302° F., and varies in specific gravity from 0·65 to 0·72. It is often sold under the names of ligroin or spirit, and is applied to a variety of purposes. In Europe it is again treated with sulphuric acid and subjected to fractionated distillation, being thus divided into four parts. The portion which passes over first at from 104° to 158° F. is known as petroleum ether, and has the specific gravity of 0·64–0·66. It serves for the extraction and solution of fatty matters, etc. The second fraction distilling from 149° to 194° F. is gasoline, known also as neoline, rhigolene, canadol, etc. Its specific gravity is 0·67, and it serves for the gasoline gas process. The third fraction, which goes over between 194° and 230° F., is petroleum benzine, which is used as a solvent and for removing grease spots. Its specific gravity is 0·69—0·71. The residue in the still is used as a substitute for oil of turpentine. Its specific gravity is 0·75, and it begins to boil at 248° F.

The second product obtained in distilling crude petroleum is the ordinary refined petroleum or kerosene used as a lamp oil. Its specific gravity is 0·82.—*Gewerb Blatt Wurtemb. Chemiker Zeitung.*

FORMULÆ FOR ANILINE INKS.

A CONTEMPORARY gives the following forms for aniline ink:

Red Aniline Ink.

Triturate in a porcelain mortar three drachms of best crystallized water-soluble roseine, and dissolve it in boiling distilled water, in the last portions of which two ounces of gum arabic has been dissolved. The amount of water depends on the tint which it is desired to produce.

N. B.—Roseine is acetate of rosaniline; the hydrochlorate of rosaniline is known as fuchsine. In place of roseine, *eosine* (or tribrom-fluorescine) may be used, which gives a yellow-red magnificent tint.

Blue Aniline Ink.

1½ oz. of the so-called "Bleu soluble Parisienne" (soluble Paris blue, also called cornflower blue), is dissolved

in a mortar in three to four quarts of boiling distilled water. Gum arabic may be added to the solution.

N. B.—Soluble Paris blue is the ammonium salt of triphenyl-rosaniline sulphuric acid, $C_{20}H_{14}(C_6H_5)_3N_3(H_2SO_4)_3H_2SO_4$.

Violet Aniline Ink

1 1-6 oz. of so-called Primula violet is dissolved in three quarts of boiling distilled water. This may be converted into a copying ink by adding four ounces of sugar, four ounces of glycerine, and ten ounces of gum arabic.

N.B.—Primula violet is known also as dahlia, or Hofmann's violet, of which there exist a number of different shades. Perhaps the finest is that known as No. 6. This coloring matter consists of salts of trimethylrosaniline, and triethylrosaniline.

Other tints may be prepared from other aniline colors.

In our experience it is best to add to the solution of an aniline color a small percentage (three to five per cent.) of alcohol, and also of glycerine (one to four per cent.)—*Monthly Mag. of Pharmacy.*

[On these receipts we would remark that gum arabic is simply a mischievous addition which deprives aniline inks of their most valuable properties, *i. e*, their perfect limpidity, their leaving no deposit on the pen, and their instantaneous drying. Cornflower blue is another name for pittacal, and is perfectly distinct from soluble Paris blue.]—*The Chemical Review.*

THE ATTRACTIONS OF THE YELLOWSTONE NATIONAL PARK.

THE Yellowstone Park embraces an area of fifty-five by sixty-five miles, and contains the most striking of all the mountains, gorges, falls, rivers, and lakes in the whole Yellowstone region. The hot springs on Gardiner's River, for example, are along its northern boundary; the Grand Cañon lies toward its northeastern corner; toward its southeastern corner stretches Yellowstone Lake, and occupying the western central portion is the wonderful Geyserland.

"This whole region," says Dr. Hayden, the United States geologist, "was, in comparatively modern geological times, the scene of the most wonderful volcanic activity of any portion of our country. The hot springs and geysers represent the last stages—the vents or escape pipes—of these remarkable volcanic manifestations of the internal forces. All these springs are adorned with decorations more beautiful than human art ever conceived, and which have required thousands of years for the cunning hand of nature to form."

Entering the park by the Virginia City wagon road, the visitor first encounters the geysers. These rival the most famous of Iceland, and deserve detailed description. The explorer—Lieutenant Barlow—tells us that near the edge of the basin, where the river makes a sharp bend to the southeast, is found the initial geyser—a small stream vent—on the right. Soon on either side of the river are seen two lively geysers called the "Sentinels," because of their nearness to the gate of the great geyser basins. The one on the left is in constant agitation, the waters revolving horizontally with great violence, and occasionally spouting upward to the height of 20 feet, the lateral direction being 50 feet. Enormous masses of steam are ejected. The crater of this is 3 feet by 10. The opposite sentinel is not so constantly active, and is smaller. About 250 yards from the gate are three geysers acting in concert. When in full action the display from these is very fine. The waters spread out in the shape of a fan, in consequence of which they have been named the Fan Geysers. One hundred yards farther up the side of the stream is found a double geyser, a stream from one of its orifices playing to the height of 80 or 90 feet, emitting large volumes of steam. From the formation of its crater it was named the Well Geyser.

Still above are found some of the most interesting and beautiful geysers of the whole basin. First are two smaller geysers near a large spring of blue water, while a few yards beyond are seen the walls and arches of the Grotto. This is an exceedingly intricate formation 8 feet in height and 90 in circumference. It is by many called the gem of all the geysers. It is absolutely magnificent—a sight of resplendent beauty that greets the eyes nowhere outside of the region of the National Park. It is simply a miniature temple of alabaster whiteness, with arches leading to some interior Holy of Holies, whose sacred places may never be profaned by eye or foot. The hard calcareous formation about it is smooth and bright as a clean-swept pavement. Several columns of purest white rise to a height of 8 or 10 feet, supporting a roof that covers the entire vent, forming fastastic arches and entrances out of which the water is ejected during an eruption 50 or 60 feet. The entire surface is composed of the most delicate bead work imaginable, white as the driven snow, massive but elaborately elegant, and so peerlessly beautiful that the hand of desecration has not been laid upon it, and it stands without flaw or break in all its primal beauty—a grotto of pearls, "the beautiful princess of all the realm."

Proceeding 150 yards farther, and passing two hot springs, a remarkable group of geysers is discovered. One of these has a huge crater 5 feet in diameter, shaped something like the base of a horn—one side broken down—the highest point being 15 feet above the mound on which it stands. This proved to be a tremendous geyser, which has been called the Giant. It throws a column of water the size of the opening to the measured altitude of 130 feet, and continues the display for an hour and a half. The amount of water discharged is immense, almost equal in quantity to that in the river, the volume of which during the eruption is doubled. But one eruption of this geyser was observed. Another large crater close by has several orifices, and with ten small jets surrounding it, formed, probably, one connecting system. The hill built up by this group covers an acre of ground and is 30 feet in height.

Wonderful hot springs burst out at many different points in the park, but those in the northern portion are most generally admired. The springs in active operation on Gardiner's River cover an area of about one square mile, and three or four square miles thereabouts are occupied by the remains of springs which have ceased to flow. Small streams flow down the sides of Snowy Mountain in channels lined with oxide of iron of the most delicate tints of red; others show exquisite shades of yellow, from a deep, bright sulphur to a dainty cream color; still others are stained with shades of green—all these colors as "brilliant as the brightest aniline dyes," declares one observer. The water, after rising from the spring basin, flows down the sides of the declivity, step by step, from one reservoir to another, at each one of them losing a portion of its heat, until it becomes as cool as spring water. The natural basins into which these springs flow are from 4 to 6 feet in diameter and from 1 to 4 feet in depth. The principal ones are located upon terraces midway up the sides of the mountain. "The largest living spring is near the outer margin of the main terrace. Its dimensions are 20 feet by 40, and its water so perfectly transparent that one can look down into the beautiful ultramarine depths to the very bottom of the basin. Its sides are ornamented with coral-like forms of a great variety of shades, from a pure white to a bright cream yellow, while the blue sky reflected in the transparent water gives an azure tint to the whole which surpasses all art."

But the brightest jewel of our wonderful park—Yellowstone Lake—must no longer pass unnoticed. It is about twenty miles long and fifteen miles broad, with a rough and irregular, but almost enchanting shore line. Its superficial area is about 300 square miles, its greatest depth 300 feet, and its elevation above the sea 7,427 feet. Lying upon the very crown of the continent, Yellowstone Lake receives no tributaries of any considerable size, its clear, cold water coming solely from the snows that fall on the lofty mountain ranges that hem it in on every side. Of this the enthusiastic Langford says: "Secluded amid the loftiest peaks of the Rocky Mountains, possessing strange peculiarities of form and beauty, this watery solitude is one of the most attractive objects in the world. Its southern shore, indented with long, narrow inlets, not unlike the frequent fiords of Iceland, bears testimony to the awful upheaval and tremendous force of the elements which resulted in its erection. The long pine-crowned promontories stretching into it from the base of the hills lend new and charming features to an aquatic scene full of novelty and splendor. Islands of emerald hue dot its surface, and a margin of sparkling sand forms its setting. The winds, compressed in their passage through the mountain gorges, lash it into a sea as terrible as the fretted ocean, covering it with foam. But now it lay before us calm and unruffled, save as the gentle wavelets broke in murmurs along the shore. Water, one of the grandest elements of scenery, never seemed so beautiful before."

Besides its entrancing shore line, the lake is dotted with numerous islands, which lend rare beauty by their luxuriant vegetation. Fish abound in the lake, game of all kinds inhabit the surrounding forests, and the placid surface of the water and grassy margins render this mountain-locked sheet the earthly paradise for myriads of water fowl. There are facilities for boating here and rather primitive summer accommodations for the tourist.

It is but a pleasant two hours' ride from the lake to the falls. The head of Yellowstone Cañon is but a short distance above the Upper Falls, and just before reaching them narrows down to a close gorge, compressing the waters into so small a passage-way that they drive through with great commotion. The first fall is only a quarter to a half a mile above the lower one, and the stream dashes over a perpendicular cliff 140 feet high. "The river is now dashed into a turbulent, foamy cascade, by its ragged bed and lightning speed, and does not again become smooth until just the instant it takes its dizzying leap of *three hundred and ninety feet* perpendicularly to its narrow bed in the depths of the great cañon. On either side of the falls, and so far as the eye can see below, there rises to a height of 2,000 feet above the river a grand, vast wall of infinite masonry, so gorgeously colored and tinted, so bounteously beautified in gilt, purple, and carmine, that no oil painting, however fine, will ever do justice to the natural picture! There is no painful glare of one color prominent over another; the Great Artist has used each brush deftly, and with His divinely exquisite touches each tint and shade is so perfectly blended that the mighty walls seem as if built by the equal commingling of all the precious metals of the world!"

The Great Falls of the Yellowstone, with their symmetrical proportions, "containing all the elements of picturesque beauty," and so intimately connected with all the strangely-fascinating enchantments of the delicately-carved and gorgeously-crowned Grand Cañon, excel in sublimity the world-known Niagara, or the soul-inspiring Yosemite. As a friend, who is given to "cold figures" and poetry at the same time, says: "The height of Niagara Falls—164 feet—is 226 feet less than our beautiful falls of the National Park. The sheet at Niagara is 1,100 feet in breadth, while that of the Yellowstone is less than 200. The discordant roar of Niagara is liquid music at Yellowstone; the majesty of the former is poetry at the latter. The waters which dash over Niagara flow through a level and monotonous region, and have a weary, business-like appearance; while the Yellowstone, gliding through a region sublime in scenery and associations everywhere, falls into the grandest cañon of the world. The former are 300 feet above the sea level, the latter 8,000! The great suspension bridge is but 258 feet above the water; a like bridge across this great cañon would rise *two thousand feet* above the little stream."

The view of the Grand Cañon from the heights above is pronounced by a widely-known traveler "the finest piece of scenery in the known world," and, indeed, it is hard to conceive of any combination of pictorial splendors which could unite so potently the two requisites of majesty and beauty. Twenty miles long, it is impassable, and inaccessible at the water's edge, except at a few points. Its rugged edges are from 200 to 500 yards apart, and its depth is so profound that no sound ever reaches the ear from the bottom. "The stillness is horrible. Down, down, down, we see the river, attenuated to a thread, tossing its miniature waves, and dashing, with puny strength, against the massive walls which imprison it. All access to its margin is denied, and the dark gray rocks hold it in dismal shadow. Even the voice of its waters in their convulsive agony cannot be heard. Uncheered by plant or shrub, obstructed with massive bowlders and by jutting points, it rushes madly on its solitary course. The solemn grandeur of the scene surpasses description. The sense of danger with which it impresses you is harrowing in the extreme."—*Resources of Montana.*

RAU'S PALENQUE TABLET.

By PROF. O. T. MASON, Columbia College, Washington, D. C.

THE last contribution to knowledge issued by the Smithsonian Institution, is No. 331 of its publications, a quarto of seventy-six pages, by Dr. Charles Rau, on the Palenque Tablet in the United States National Museum. The contents of the work are as follows: "Chapter I.—History of the Palenque Tablet; Chapter II.—Explorations of Palenque; Chapter III.—The Temple of the Cross; Chapter IV.—The Group of the Cross; Chapter V.—Aboriginal Writing in Mexico, Yucatan, and Central America; Appendix.—Notes on the Ruins of Yucatan and Central America." In the first chapter we have a minute relation of the manner in which the tablet found its way from the Temple of the Cross to its present position in the National Museum. In the second chapter Dr. Rau gives a narration of various explorations of these interesting ruins. The name Palenque is derived from a village about eight miles away, called Santo Domingo del Palenque. The ruins were discovered in 1750, by a party of Spaniards, and surveyed for the first time by order of Ramon de Ordonez in 1773–1784. The first exploration which led to any result was that of Capt. Antonio del Rio in 1787; his manuscript was published in London, in 1822, with drawings from Castaneda, the artist of Dupaix. Capt. William Dupaix, in 1808, visited Palenque, with an artist named Castaneda. The MSS. and drawings will be found in Vols. IV., V., VI., of Kingsborough. Baron de Waldeck lived two years at Palenque, making surveys and sketches, 1832–4. His plates, with text by De Bourbourg, were published in Paris, in 1866, by the French Government.

When Dupaix visited Palenque the three slabs constituting the Group of the Cross were all in place. But at the time of Waldeck's visit, the right one, now called the Smithsonian Tablet, was in fragments on the floor; the middle one had been carried off to the banks of the river by a vandal who wished to adorn his house with it; and the one on the left was in its original position, which it now occupies. Stephens and Catherwood visited the spot in 1840, and were entertained by Mr. Charles Russel, our consul at Laguna. They made drawings of the ruins, and shortly after their visit the fragments of the right-hand slab were sent to the National Institute in Washington, where it arrived in 1842. The site has since been visited by Arthur Morlet in 1846, and M. Désiré Charnay, for the French Government, in 1857. The tablet was transferred to the Smithsonian Institution in 1858, and in 1863, while making a cast for Prof. Henry, Dr. George A. Matile discovered that this was the missing slab from the Palenque group, not drawn by explorers after Dupaix. It was broken again after Dr. Matile's cast was made, but reconstructed and set in its present frame, from which Dr. Rau's photograph was taken. Whatever doubt may have remained after Matile's argument is now dispelled by reference to the outline plate of Dr. Rau's work, in which the whole Group of the Cross is again restored.

The occurrence of the sign of the cross in America, anterior to its discovery by Columbus, has been the marvel of archæologists. But the fact of its appearance in may places where Christian influence had never been felt compelled the student to look for other motives in its existence. The whole subject is reviewed in Chapter IV., pp. 39–46. Of equal interest with the allegorical sculpture is the subject of the hieroglyphics, on which Dr. Rau has bestowed a great deal of faithful study. The supposed key to their interpretation is a MSS. found in the Royal Library of Madrid, by Brasseur de Bourbourg, in 1863, which is a copy of one composed by Diego de Landa, in 1579, and giving, among other things, an alphabet of thirty-three signs. It will be remembered that a similar old MSS. is mentioned by Sr. Orozcoy Berra, in Anales del Museo Nacional de Mexico, containing the Lord's Prayer in symbols, partly Aztec and partly ecclesiastic. All attempts to interpret the Central American glyphs and manuscripts by Landa's alphabet have proved failures. Dr. Rau, the most cautious of theorists, does not attempt a solution, but on page 61 gives a diagram of his outline plate, by which every glyph on the tablet may be easily referred to (it is a pity that the letters and figures do not occur on the margin of the plate itself). On pages 62 and 63 some of the glyphs are analyzed, and the places where the elements are to be found are indicated. The author concludes that the analogies between Landa's signs and the glyphs warrant the suggestion that the inscriptions constitute a chronological record of some kind. On pages 53 and 64, Dr. Rau corrects an error of Humboldt, Kingsborough, Stephens, and others, as to the close relationship between the Aztecs and ancient Mayas, based on the Dresden Codex, which is clearly shown to be of Maya and not of the Mexican origin at all.

On page 75 the author reaffirms the view of Stevens, Bancroft, as well as his own, "that the Yucatan structures were built by the Mayas, the direct ancestors of the people found on the peninsula at the Conquest and of the present native population."—*American Naturalist.*

THE MYLITTA OR TASAR SILK WORM.*

By ALFRED WAILLY, Membre Lauréat de la Société d'Acclimation de France.

THE *Mylitta*, or Tasar silkworm, which is found all over India, and also in Ceylon, is the most valuable of the Indian wild silk-producing Bombyces, and it is extremely polyphagous. In India, it feeds on *Terminalia tomentosa, Zizyphus jujube, Lagerstrœmia indica, Ficus benjamina, Carissa, Guidia*, and other trees. Last year, in England (where I introduced it for the first time), and also in France and Germany, it has been reared on oak, and, by Mr. P. H. Gosse, on horn-beam.

The various races of *Mylitta* vary considerably in size, according to the different localities where they are found. The cocoons are oval and silvery-white, or yellowish. Some are 2 in. long and 1¼ in. in diameter, and even more; others, only about 1 in. in length. The difference in size of the various races of the same species is very likely due to the quality of the foliage they feed upon.

In the forests of the Himalaya and other parts, where the foliage is abundant and keeps fresh, the worms grow to a considerable size; but, in localities where the weather is hot and dry, the foliage withering in a short time, the worms undergo their changes in a shorter time, and, in consequence, form much smaller cocoons.

This, of course, refers to worms living in a wild state; but, should they be reared on trees properly attended to and kept in good condition, it is possible that the worms of the various races would all produce large cocoons. As a proof of this assertion, I may mention the success obtained in a part of the Bombay Presidency, where the climate is hotter than in the Himalaya Mountains, by Major G. Coussmaker, who, for several years, has reared this species, and obtained cocoons equal in size to those I received last year from Calcutta, and which came from the Himalaya.

The Himalaya race of *mylitta* is *uni-voltine* (single brooded), the moths emerging about the beginning of July; the races from the south of India and Ceylon, like all species of tropical insects, are *poly-voltines* (many-brooded). One of my correspondents in Colombo, to whom I had written for cocoons, in a letter dated 16th January, 1879, says: "I have some cocoons of *mylitta*, but the moths are emerging."

At the end of June, 1879, I received from Calcutta a small case containing 55 cocoons of the Himalaya race of *Attacus mylitta*, which is one of the largest. The cocoons having been sent too late, the moths emerged on the way, but a few

* From the Hindostani *tussurie*, which means shuttle.

cocoons escaped, from which, in a few days, emerged large and magnificent moths. From the two first couples I obtained two pairings; the other moths were all females.

The couples were placed in small separate cages, and in the open air, under a roof. The first male and female moths, born in the evening, the 6th of July, paired in the night of the 7th, the pairing lasting 42 hours. The pairing of the second couple, which took place the following night, lasted 48 hours. I never had any species of moths the pairing of which lasted so long. I was so anxious about the success of my first experiment with this species that I paid a visit to the first couple in the middle of the night, when I was agreeably surprised to see that success had been obtained, and that in spite of the rather unfavorable weather.

I was afraid of failure after reading a description of *mylitta* in vol. xxxii. of the "Naturalist's Library," edited by Sir William Jardine, in which the writer of the memoir on *mylitta* says that this species cannot be domesticated. This evidently refers to a race of *mylitta* with habits very different to those of the Himalaya race, as it is further stated "this species cannot be confined, for, as soon as the moth pierces the cocoon, it gets away, and the people add that it is impossible to keep it by any precaution whatever." In another part of the memoir, the following extraordinary statement is made: "I have frequently endeavored to detain the males of the Jarroo species, and have kept them locked up in a box for that purpose; but, whether they did not like to make free with their female relations, or from what other cause I know not, but I never could obtain a breed in the domestic state; and the efforts of the male to escape were wonderful, and, at last, always effectual." The Jarroo species alluded to is that from which the cocoons are obtained during the coldest month of the year—January.

Although I could not take the above statements in a literal sense, I feared it was impossible, or at least difficult, to cause the *mylitta* moths to pair in captivity. Fortunately, the moths of this great and valuable species paired readily, and for a considerable time (a most important thing), and the females laid their eggs for several days without even damaging their wings. Contrary to some small species of *mylitta*, which are restless, the moths of this large race were extremely quiet; they could be taken by the hand and placed anywhere without letting themselves fall. The male moths must have been as quiet as the female, as they were, after the pairings had taken place, as fresh as they were after emerging from the cocoons.

The two female *mylitta* laid about 450 ova altogether. These egs are of a whitish color, round, rather compressed, generally with two lines encircling them; they are somewhat larger than the eggs of *Yama-mai* and *Pernyi*. Some of the ova are smaller than the others, and very likely they produce the male larvæ.

The hatching of the ova commenced on the second of August. The smaller larvæ, in the first stage and when just hatched, were light-brown or buff, the larger ones of a greenish tint. In a few days they all became of a more uniform color. Round each segment there is a black line. The head and legs of the larvæ are black, and there are black spots on the body.

The second stage commenced on the 10th of August. The larva was then yellow-green; no black lines round the segments: the head and legs, as in the first stage, black or blackish brown; black spots as before.

The third stage commenced on the 17th of August. Larva fine green; head and legs, as before, black. Dark spines, with base of a brilliant metallic copper color.

The fourth stage commenced on the 29th of August. From that date, I regret to say, I was obliged to discontinue my rough descriptions of the larvæ, which, up to that time, after thriving admirably without a single fatality, commenced to die, two, three, or more every day, till all were gone within about twelve days—about sixty worms in all. They were fed on oak.

The death of the *mylitta* larvæ I attribute to several causes. The cold weather compelled me to rear them in a room, and I kept them too long under bell-glasses; perhaps they had not a sufficient amount of fresh air, although the large glasses were raised to renew it. After the first stage, it would have been best to rear them entirely uncovered, on oak branches plunged in water, as they did not much wander then. I rear successfully many species under glass, but some of the larger species do best uncovered, with a free ventilation, and better still in the open air.

I feed my larvæ like *Yama-mai* and *Pernyi*, with hard leaves on old oak branches, and, from what I subsequently learnt from Herr Huesmann, it would seem they prefer young and tender leaves, such as those produced by suckers or shoots of the year; but experience alone will teach us the best method of rearing this valuable species. My impression now is that, the foliage being too hard, the worms could not eat sufficiently, and that they were gradually starved.

Mr. P. H. Gosse, writing to me on September 12, 1879, says: "My two *mylitta* larvæ are about 3½ in. in length and $\frac{7}{16}$ths in depth. Fine apple green, with a yellow line on each side; upper tubercles, burnished copper; middle and lower tubercles, purple; spiracles, orange; face, dark brown. I have fed them, as many others, on horn-beam (a valuable discovery of mine)."

In a subsequent communication, dated September 30, 1879, which Mr. Gosse was kind enough to send me, he says, "In reply to your questions, the *mylitta* larvæ I described in the fifth stage, when full grown. Both have since died. Fatality has attended almost all my species (*Pyri*, *Cecropia*, *Promethea*, *Cynthia*, *Selene*) except *Hyperchiria io*, which has done very well."

Major G. Coussmaker, in his "Memoir on *Mylitta*," published in 1873, says the larvæ moult five times. From this we must conclude that Mr. Gosse's larvæ were in the last stage but one. Two larvæ I received from Herr Huesmann, on the 29th of October, in the sixth and last stage, were of an enormous size.

Lord Walsingham, to whom I sent them for preservation, kindly wrote to me on October 31: "I am much obliged for the two larvæ of *mylitta*. I am sorry to say that I have failed to preserve them satisfactorily, their brilliant pale-green color being quite impossible to retain, and their size rendering them very difficult subjects."

The larva in its sixth stage was this: On the back, 18 brilliant copper tubercles, and two rows of small purple spines on each side; a yellow, lateral stripe on each side; head, dark brown.

Major Coussmaker, in the description of his *mylitta* larva says that, "when hatched, it is blackish-brown, with a shining black head, and that, as it increases in size, the color of the body turns yellow. After the first moult, the head becomes of a blood-red color; the color of the body is of a greenish tint, and after each moult it becomes greener." Major Coussmaker adds, "When full-grown, a fine specimen is, at least, 7 in. long and 1 in. in diameter. I have weighed one of these dimensions when 45 days old, and found it to be 371 grains."

From what has been said, it will be seen that the rearing of *mylitta* last year was of very long duration, from the beginning of August till the end of October; therefore, in England, and other northern countries, artificial heat will be required to bring the larvæ to the formation of their cocoons. No success could be obtained in the open air.

But in southern European countries, such as Spain, for instance, where the *Yama-mai* and *Pernyi* oak silk-worms are already thoroughly acclimatized and reared in immense quantities, it is to be hoped the *mylitta* will be equally successful.

In August last, I received a letter, dated 27th of July, 1879, from Major Coussmaker, from which I shall quote the following passage: "My system of rearing is very simple and methodical. I keep all my seed-cocoons in a basket, with the pedicles uppermost. At intervals, between 6 and 11 P.M., I look at them, and if I see any moist at the top, I tie them on to a branch of any tree or shrub in my garden, and at daylight I find that the females are paired in the vicinity of their cocoons, while the males have gone away to seek for mates.

"They are left in that condition all day, and at sunset, or when I am going out for a walk, I take the females, let the males fly, and put the females to lay their egs. The next morning I take the eggs away, and put them into a small box or something of the kind, safe from rats, mice, and ants.

"In nine days they hatch out, and I put them on to shrubs over which I put screens of split bamboo. As the worms grow, they eat the shrubs quite bare, while I move the screens as necessary. To facilitate this moving, I have planted my shrubs in hedges, and now it is only a matter of the food and number of worms.

"From a month to six weeks, according to the moisture and luxuriance of the foliage, the worms take to make their cocoons, and, as far as I can see, success seems certain. The plants I use are the varieties of *Lagerstrœmia*, *Zizyphus*, *Terminalia*, and *Carissa*. I am not aware as to whether any of these trees can be obtainable in England, or whether the worms will hatch out there. The moths paired and laid eggs in 1874, but did not hatch. I hope that you will be more successful."

To conclude, I will now quote a few short passages from Herr Huesmann's letters to me: October 15, 1879—"My *mylitta* larvæ are doing very well, but are growing very slowly; up to this day, only four have formed their cocoons, but these are fully as large as the imported ones. Please to consider that my *mylitta* larvæ are exactly the same age as my *selene*, which partly are moths to-day." October 22—"The first *mylitta* larvæ hatched on July the 31st and commenced to spin on October the 2d, about half of this long time having been spent in the last stage. I never bred *mylitta* larvæ before, but have seen them reared in Bremen two years ago. The larvæ I saw in Bremen were a good deal smaller than mine, and their cocoons, of which I had some in my possession afterwards, produced very small and mean-looking moths. I fed my larvæ on the common oak, but always picked out young sprigs with large and succulent leaves."

At the end of October the larvæ had not all formed their cocoons.—*Journal of the Society of Arts.*

RULES FOR THE MANAGEMENT OF LAYING HENS.

By Dr. A. M. Dickie.

A few simple rules applied to the management of laying hens will insure a full supply of eggs throughout the year. But the small number of rules and their simplicity make it imperative that they be understood and applied. A long essay might be written on each topic embraced in the subject, but I will limit myself to as condensed a statement as will cover the ground, and still be plain enough for any one to understand.

No one, so far as I have observed, has succeeded in any business undertaking without giving it a share of his time and attention proportionate to its importance. This is as true in reference to egg-production as in any other kind of business. Hens require some care and attention. Unless their owner is willing to see to his hens he had better not have them.

Hens must have comfortable and convenient quarters in winter. Most people keep too many hens for the accommodation they furnish them. Hens are naturally active animals, and when confined in winter quarters require plenty of room. Fifty hens and four cocks, of all ordinary breeds, should have a house 24 by 16 feet in the clear, and 10 feet high in the clear. This will allow about 70 cubic feet of space for each fowl, which is little enough. No class of animals is so susceptible to the ill effects of crowding as the feathered class. Hens will not lay when too much crowded, nor will they remain healthy long if too many are kept together. The building should be well ventilated without admitting any gusts or draughts of wind. It should face the south if possible and have several windows in front. Where the weather gets very cold it will be well to have the whole front glazed and have a stove inside. Hens cannot lay unless they are kept comfortable, and when the temperature falls to 12° or lower they require a little artificial heat. This heat must be carefully managed; a little fire only should be kept, and it should be as steady as possible. Uniformity of temperature is what is wanted. The houses must be kept clean and neat. The floors should be swept every day, and be dusted over with dry earth, ashes, chaff, short straw, or litter of any kind that can be easily removed. Every hen house should have plenty of suitable roosts. There should be a shallow box or bin in one corner—a sunny corner is best—containing dry earth, ashes, dry chip dirt, or a mixture of them for the hens to wallow in; they enjoy their bath in winter as much as in summer. Where oyster shells cannot be easily procured there should be a box containing gravel within reach of the fowls. A sufficient number of nest boxes with glass nest eggs in them, several shallow vessels for water and feed trough will complete the necessary outfit for the hen house. A very important adjunct to the hen house is an open shed where the fowls can stay at pleasure when the weather is not too cold. Such a shed should protect the hens from the prevailing winds.

When the house with all the necessary fixtures is ready for the stock, the next consideration is to have the right breed. Almost any breed will do tolerably well with proper usage; but there is a great difference in the laying qualities of fowls. Under the same conditions some breeds will lay twice or thrice as many eggs in a given time as others. As a rule the smaller breeds are the best layers; and of the smaller breeds the Leghorns are preferable for various reasons; they lay a full medium sized egg, are enormous layers, are docile and easily restrained, and have a yellow skin. Of the large breeds the Brahmas are the best layers. A cross of a Leghorn cock on light Brahma hens will be satisfactory. Where one wishes to make eggs a specialty only pullets should be kept for the purpose, and the earlier they are hatched the better. Don't keep hens over more than one winter unless for some good reason.

When the proper accommodations are furnished and the proper breeds selected, the next and most important step is the feeding. Egg-production is hard work for hens, especially for those that are large layers. An egg is a highly organized and complex substance. It is for the most part composed of albuminous matters and oils or fats, together with fibrin, phosphorus, sulphur, iron, etc., in small but appreciable quantities. An egg is a potential chicken. The hatching process adds nothing to the contents of the egg, but only develops the chick from the substance already there. Thus in an egg there is the material for bones, flesh, blood, brain, nerves, feathers, and all the organs of life. Hence egg-production considered physiologically is an exhaustive process when hens lay regularly and constantly. Furthermore the shells of eggs are composed almost exclusively of carbonate of lime. When a hen lays freely she requires a supply of the raw material from which to secrete this carbonate, and it should be furnished to her at all times. Is it a wonder then that hens, as they are ordinarily kept, do not lay in winter? Their food must contain the materials from which they secrete eggs or they cannot lay. Probably nine-tenths of all the poultry in the country are fed on raw, whole corn. We know that corn contains all the elementary substances that eggs do, but in very much smaller quantities bulk for bulk, and when a hen has no other food she cannot eat enough to afford the materials for an egg a day, or every other day. She will get fat and lazy, but cannot lay. *Hence the necessity for a variety of diet.* In summer, when at liberty, the hens can find the variety of food that suits them, and generally lay well without much care; but in winter they can get only what is given them, and generally they do not lay. But if we know the wants of the hens and supply them we may have as many eggs in winter as in summer. Poultry are large consumers of grass when they can get it, and to keep in good health they must have it or its equivalent in winter. Cabbages or boiled vegetables of any kind are good substitutes. Grass if cut green and carefully dried in the shade, when cut fine and steeped a while in hot water is nearly as good as green grass, and is eagerly eaten in winter. Besides grass or its equivalent we must give a supply of lime. Oyster shells when they can be had are the most convenient; when they cannot be had ordinary stone lime from the kilns will do as well after it is slacked, but gravel must be supplied with this latter form of lime. Domestic poultry must be classed among the omnivorous animals. There is nothing that can be eaten that a hen will not eat if she can get it; any kind of odds and ends, therefore, will not come amiss, and much refuse matter that would otherwise be wasted may be thus turned to good account. Hens are very large consumers in proportion to their size, and scanty feeding in winter will not do. They should have as much as they want to eat and as often as they want it, especially when they are laying well. They should be supplied with animal food in some form, offal meat, cracklings, chandler's scraps, thick sour milk, etc., will give the necessary supply.

It thus appears that an egg is a complex substance; that it is composed of the highest products of secretion; that egg-production is an exhaustive process to the hen; that to produce them in large quantities we must supply the proper variety of diet, and plenty of it; and to keep up the health and strength of the hens they must have green food and animal food in winter.

I have made out a bill of fare for my hens based upon physiological principles, keeping in view the composition of the egg itself, and the health and comfort of the hen. I will not occupy space in showing why this is in accordance with theoretical principles or analytic results. I do not claim that it is the best or the only way to feed hens, but it has answered so well with me that I do not know how to alter it for the better. My hens have laid enormously, and have, through the medium of printer's ink, become famous.

This is how I feed: Their morning feed consists of cracked (very coarsely ground) corn, wheat screenings, or wheat, or oats, and wheat bran *scalded* and fed warm in a trough. This is given them as soon as they can see to eat. As soon as they are fed I break up a pound of oyster shells for thirty-five head. Then they have fresh water from the pump, as much as they will drink. Fowls often suffer for water in winter. After I have had my own breakfast I give them about a pound of scraps or cracklings from the chandler's shop. This is broken in pieces with a hatchet. It furnishes animal food, and is cheap; fresh meat is better, but dearer. I give two or three quarts of thick sour milk every day, with a handful or two of wheat bran stirred into it. Besides this, I feed some cabbage, or turnips, or potatoes every day. At noon, they have a little corn, or oats, or screenings, as the case may be, and fresh water again in clean vessels. At night, before roosting time, they get as much whole corn as they will eat, and fresh water again: I make it a rule to give as much as they will eat. A hungry hen will not be a laying hen. My hens never get too fat to lay.

The greatest regularity should be observed in feeding and caring for flocks. Have a regular time for all the different operations, and the hens will become as methodical as their keepers. Eggs should be gathered punctually twice a day, or oftener in very cold weather. The morning feed should not be made too wet, and should not be given too hot. If some of it freezes before it is eaten, break it up with a hammer and it will all be consumed. In very cold weather it is advisable to put a little cayenne pepper and a sprinkle of salt in their morning feed. Besides the above enumerated articles the hens should have all the scraps from the table. They are very fond of them, and will turn them to better account than cats or dogs will.

Let us recapitulate. Give your hens a reasonable share of your attention; furnish suitable accommodations; get and keep the right breed; *do not keep too many.* Fifty hens and four cocks are as many as should ever be kept together—half the number will do better per capita. Save only pullets, the earliest hatch for laying. Furnish as great a variety of diet as possible, and feed as much as they will eat. Give green food and animal food of some sort in winter. Keep the hens quiet and comfortable; don't allow them to be worried or frightened. Water is as important as food, and should be kept clean and fresh. These rules intelligently applied will secure an abundant supply of eggs at all times of the year.—*Fanciers' Journal.*

[Continued from SUPPLEMENT No. 229, page 3654.]

FOREST TREES OF NORTH AMERICA.

By CHARLES S. SARGENT, Arnold Professor of Arboriculture in Harvard College, Special Agent Tenth Census.

105. *Amelanchier Canadensis*, Torr. and Gray. *Mespilus arborea*, Michx. f. (June Berry. Shad Bush. Service Tree.) Hudson's Bay south to Florida, and west to Nebraska and the Indian Territory. Wood exceedingly hard, heavy, strong. A small tree, sometimes 30 feet in height, or often a shrub, running into many forms, the best marked var. *Botryapium*, Torr. and Gray; var. *oblongifolia*, Torr. and Gray. The small fruit sweet and edible.

HAMAMELACEÆ.

106. *Liquidambar styraciflua*, L. (Liquidamber. Sweet Gum. Bilsted.) Greenwich, Fairfield County, Connecticut, south to Florida, and southwest to Missouri and Arkansas; in Mexico and Central America. Wood reddish, compact, fine-grained, moderately tough and solid. A tree 40 to 60 feet in height, with a trunk 3 to 5 feet in diameter.

RHIZOPHORACEÆ.

107. *Rhizophora mangle*, L. (Mangrove.) Southern Florida, Louisiana, Texas, and southward through tropical America. A small tree; always in maritime swamps.

108. *Conocarpus erecta*, L. (Button Tree.) Tampa Bay, Florida, and southward through the West Indies to Brazil. A small tree or shrub; along muddy marine shores.

109. *Laguncularia racemosa*, Gærtn. (Black Button Wood. White Mangrove.) Southern Florida, and through the West Indies to Brazil. A small tree, or more often a shrub.

MYRTACEÆ.

110. *Eugenia buxifolia*, Willd. Southern Florida and through the West Indies. A small tree.

111. *Eugenia dichotoma*, DC. Southern Florida and through the West Indies to Central America. A small tree.

112. *Eugenia procera*, Poir. Southern Florida and through the West Indies. A small tree.

CACTACEÆ.

113. *Cereus giganteus*, Engelm. Am. Jour. Sci. (2 ser.), 14. 335, and 17. 231. Valley of the Gila River, Southwestern Arizona; and in Sonora. A tree 25 to 60 feet in height, with a trunk sometimes 2 feet in diameter.

ARALIACEÆ.

114. *Aralia spinosa*, L. (Angelica Tree. Hercules' Club.) Pennsylvania and Kentucky; south to Florida, west to Missouri and Eastern Texas. A shrub or "tree, which in rich soils (Louisiana) attains the height of 30 to 40 or even 60 feet, with a diameter of 3 to 12 inches" (Professor Carpenter); the bark yielding a diaphoretic stimulant.

CORNACEÆ.

115. *Cornus Florida*, L. (Flowering Dogwood.) Canada to Florida, west to Eastern Kansas; southwest to Arkansas and Eastern Texas. Wood hard, heavy, fine-grained, susceptible of a beautiful polish. A small tree, sometimes 30 to 40 feet in height; the bark used as a tonic and astringent.

116. *Cornus Nuttallii*, Audubon. In California, Monterey, and Mendocino Counties, and from Mariposa County north to Puget Sound; in Oregon and Washington Territory east into the Cascade Mountains. Wood very hard, close-grained, strong. In California, a small tree; at the north, often 70 to 80 feet in height.

117. *Nyssa capitata*, Walt. *N. candicans*, Michx. (Ogeechee Lime. Sour Tupelo.) Ogeechee River, Georgia, south to Florida, and west to Louisiana and Southern Arkansas. A small tree, rarely 30 feet in height; in swamps and on the banks of streams. A conserve, known as "Ogeechee Limes," is prepared from the large acid fruit of this species.

118. *Nyssa Caroliniana*, Poir. *N. aquatica*. (Gum Tree.) North Carolina to Florida, and west to? Wood firm, close-grained, very unwedgable; employed for hubs of wheels, hatter's blocks, and similar uses. A small or medium-sized tree; in swamps and wet ground.

119. *Nyssa multiflora*, Wang. *N. aquatica*, L. in part. *N. biflora*, Michx. (Tupelo. Sour Gum. Pepperidge.) West Milton, Vermont, south to Florida; west to Michigan, Missouri, and Arkansas. Wood very unwedgable; employed for hubs of wheels, etc. A small or medium-sized tree; in swamps and low ground.

120. *Nyssa sylvatica*, Marsh. *N. villosa*, Michx. *N. multiflora*, var. *sylvatica*, Watson, Index. (Black Gum.) Banks of the Schuylkill River, Philadelphia (Michaux f.); southward to Florida, and west through Kentucky and Tennessee. A large tree; its specific characters not yet satisfactorily defined.

121. *Nyssa uniflora*, Wang. *N. aquatica*, L. in part. *N. tomentosa*, Michx. *N. grandidentata*, Michx. f. (Large Tupelo. Cotton Gum.) Southeastern Virginia, south to Florida, near the coast; west to Kentucky? Louisiana, and Southern Arkansas. Wood light, soft, unwedgable; somewhat employed for wooden ware; that of the roots very light, supplying a substitute for cork. A large tree; in water or deep swamps.

CAPRIFOLIACEÆ.

122. *Sambucus glauca*, Nutt. (Elder.) Throughout California, Oregon, and Washington Territory; east into Montana and Idaho; on the mountain ranges of the "Great Basin;" east to the Wasatch Mountains, and in Southern New Mexico. A small tree, sometimes 20 feet in height, or often a shrub.

123. *Viburnum lentago*, L. (Sheep Berry.) Hudson's Bay and the Saskatchewan, southward through the Northern States; west to Fremont County, Iowa, and south along the Alleghany Mountains to Georgia. A small tree, 15 to 20 feet in height. Most common at the North.

124. *Viburnum prunifolium*, L. (Black Haw.) Fairfield County, Connecticut, and Fishkill Landing, New York, south to Florida, and west to Saint Louis County, Missouri, Arkansas, and Eastern Texas. A small tree, 15 to 20 feet in height.

RUBIACEÆ.

125. *Pinckneya pubens*, Michx. (Georgia Bark.) South Carolina to Middle Florida; in swamps near the coast. A small tree; the bark with the taste and medicinal properties of Cinchona.

ERICACEÆ.

126. *Arbutus Menziesii*, Pursh. *A. laurifolia*, Lindl. *A. procera*, Dougl. *A. Texana*, Buckley. (Madrona.) Puget Sound, southward through the coast ranges of California to Southern Arizona, and in Western Texas and Mexico. Wood white, hard, brittle. A large tree at the North, rarely more than a shrub at the South.

127. *Arctostaphylos pungens*, HBK. (Manzanita.) Southern California, Southern Utah, Arizona, and south into Mexico. Wood hard, heavy, mahogany-colored, and susceptible of a brilliant polish; employed in the best cabinet work. A shrub, often 20 feet in height, or probably sometimes a small tree.

Var. platyphylla, Gray. *Arctostaphylos glauca*, Watson, King Rep. v. 210 [not Lindl.] Oregon south through California to Western Arizona, and in the Wasatch Mountains. The common Manzanita of Northern and Central California.

128. *Arctostaphylos glauca*, Lindl. (Manzanita.) California, Monterey, and through the southern portion of the State. Wood probably similar to that of the last species. A shrub or small tree, sometimes 25 feet in height, with a trunk a foot or more in diameter.

129. *Oxydendrum arboreum*, DC. *Andromeda arborea*, L. (Sorrel Wood. Sour Wood.) Pennsylvania and Ohio, south to Florida, Mississippi, and Arkansas; principally in the Alleghany Mountains. A small tree, sometimes 40 to 60 feet in height.

130. *Kalmia latifolia*, L. (Laurel. Calico Bush. Spoon Wood. Ivy.) Canada, Maine, and Northern Vermont; south to Western Florida and Alabama; west to Wisconsin (Lapham), and through Kentucky and Tennessee to Arkansas. Wood exceedingly hard, heavy, close-grained, strong; used for handles of tools, and furnishing a valuable fuel. Generally a shrub; in the southern Alleghany Mountains sometimes a tree 30 to 40 feet in height, with a trunk 1 to 2 feet in diameter.

131. *Rhododendron maximum*, L. (Great Laurel. Rose Bay.) Nova Scotia, Southern Canada, Northern New England, and south along the Alleghany Mountains; never on limestone. Wood hard, heavy, very close-grained. Generally a shrub; in the southern Alleghany Mountains often a tree 30 to 40 feet in height, with a trunk a foot or more in diameter.

MYRSINACEÆ.

132. *Myrsine rapanea*, Rœm. and Schult. *M. floribunda*, Griseb. *M. Floridana*, A.DC. *Rapanea Guyanensis*, Aubl. *Samara floribunda*, Willd. Southern Florida, and through the West Indies to Southern Brazil. A shrub or small tree.

133. *Ardisia Pickeringia*, Torr. and Gray. *Cyrilla paniculata*, Nutt. *Pickeringia paniculata*, Nutt. Eastern and Southern Florida, and through the West Indies to Mexico. Generally a shrub; on the Florida Keys a small tree 20 feet in height.

SAPOTACEÆ.

134. *Chrysophyllum microphyllum*, DC. Southern Florida, Caloosa River, and near Miami (Garber); and through the West Indies. A small tree.

135. *Chrysophyllum oliviforme*, Lam. *C. monopyrenum*, Swartz. Southern Florida and through the West Indies. A small tree.

136. *Sideroxylon mastichodendron*, Jacq. *S. pallidum*, Spreng. *Bumelia pallida*, Swartz. *Bumelia fœtidissima*, Nutt. Charlotte Harbor and Key West, Southern Florida, and through the West Indies.

137. *Dipholis salicifolia*, A.DC. *Achras salicifolia*, L. *Bumelia salicifolia*, Swartz. Keys of Southern Florida, and through the West Indies to Brazil. A tree, 60 feet in height.

138. *Bumelia cuneata*, Swartz. *B. myrsinifolia*, A.DC. *B. parvifolia*, A.DC. *B. angustifolia*, Nutt. *B. reclinata*, Torr. Southern Florida, Tampa Bay to Key West; Texas, from Laredo on the Rio Grande to the mouth of that river, and southward into Mexico. A small tree, 20 to 30 feet in height.

139. *Bumelia lanuginosa*, Pers. *B. tomentosa*, A.DC. *B. oblongifolia*, Nutt. *B. ferruginea*, Nutt. Georgia and Florida; Southern Illinois (opposite Saint Louis) to Alabama; Missouri, Arkansas, and Eastern Texas. A small tree, 20 to 30 feet in height, with a trunk sometimes two feet in diameter.

140. *Bumelia lycioides*, Gærtn. (Iron Wood. Southern Buckthorn.) Coast of Virginia and Southern Illinois to Florida and Eastern Texas. A small tree, 20 to 30 feet in height.

141. *Bumelia tenax*, Willd. North Carolina to Florida, near the coast; in sandy soil. Wood hard, heavy, very tough. A small tree, 20 to 30 feet in height.

142. *Mimusops Sieberi*, A.DC. *M. dissecta*, Griseb. *Acras Zapotilla*, var. *parviflora*, Nutt. (Naseberry.) Keys of Southern Florida, and through the West Indies. A small tree, sometimes 30 feet in height; the edible and agreeable fruit the size of a pigeon's egg.

EBENACEÆ.

143. *Diospyros Virginiana*, L. (Persimmon.) Light-House Point, New Haven, Connecticut, south to Florida and Alabama; Ohio to Iowa, Missouri, Kansas, and south to Louisiana. Wood brownish, hard, heavy, very close-grained; employed in turnery, for shoe lasts, etc. A tree, 20 to 70 feet in height; the yellow edible fruit exceedingly austere until after frost, then becoming sweet and luscious.

144. *Diospyros Texana*, Scheele. (Mexican Persimmon.) Southern and Western Texas, and southward into Mexico. Wood white and heavy. A small tree, 10 to 30 feet in height; "fruit globose, black, luscious, ripe in August."—Gray, Syn. Fl. 1, 70.

STYRACACEÆ.

145. *Symplocos tinctoria*, L'Her. *Hopea tinctorea*, L. (Horse Sugar. Sweet Leaf.) Southern Delaware to Florida; west to Louisiana and Southern Arkansas. A small tree or shrub; leaves sweet to the taste, greedily eaten by cattle and horses, and yielding a yellow dye.

146. *Halesia diptera*, L. Georgia to Florida, Louisiana, and Southern Arkansas. A small tree or shrub.

147. *Halesia tetraptera*, L. (Snow-drop tree. Silver-bell Tree.) West Virginia to Southern Illinois; south to Arkansas, Louisiana, and Florida; principally along the southern Alleghany Mountains. A small or, in the mountains, medium-sized tree, with a trunk sometimes exceeding 18 inches in diameter.

OLEACEÆ.

148. *Fraxinus Americana*, L. *F. acuminata*, Lam. *F. alba*, Marsh. *F. juglandifolia*, Lam. *F. epiptera*, Michx. *F. Curtissii*, Vasey. (White Ash.) Nova Scotia and New Brunswick, to the western shores of Lake Superior; south to Florida and Louisiana; west to Eastern Nebraska and Kansas. Wood light, tough, very strong, elastic; extensively employed in the manufacture of agricultural implements, carriages, oars, cabinet work, etc. A tree 60 to 80 feet in height, with a trunk 4 to 6 feet in diameter; of the first economic value.

149. *Fraxinus anomala*, Torr. Watson, King Rep. v. 283. Labyrinth Cañon, Colorado River, and near Saint George on the Rio Virgen, Southern Utah. A small tree, 10 to 20 feet in height.

(To be continued.)

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